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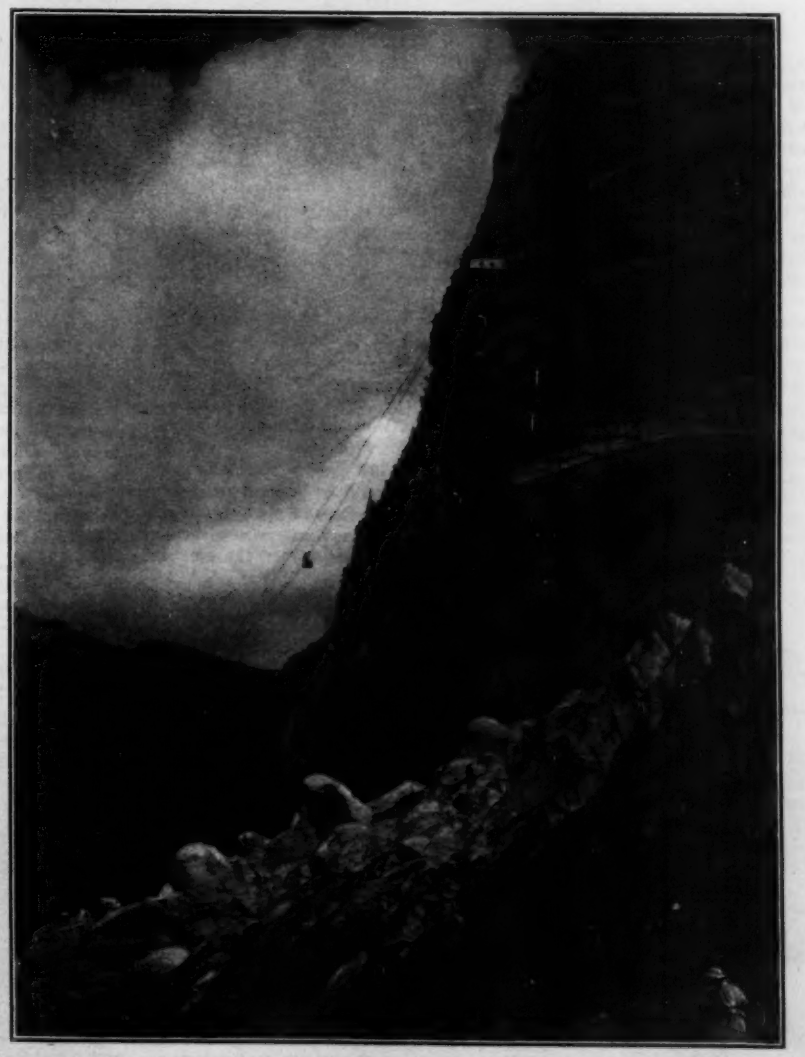
The Wetterhorn Cableway Incline.

An interesting cableway incline was put into operation in the Berner Oberland of Switzerland last summer. It climbs the first stage of the Wetterhorn ascent, and has a remarkably steep gradient; its rise is 1,370 ft., in a horizontal distance of 1,197 ft. There are novel features in the cable arrangement and in the safety brake mechanism, which were described in the "Schweizerische Bauzeitung" of Dec. 12 and 19, 1908. From the latter we abstract a description of the essential features. The cableway has fixed or standing ropes as track cables, and separate hauling ropes which are wound up by horizontal drums at the upper station. There are two sets of track cables and two cars, the cars balancing each other through the hauling ropes. The peculiarity of the cable arrangement is that all the ropes are in duplicate, which necessitates equalizers in order to divide the load equally between the two.

The safety devices include, beside the usual automatic brakes and hand brakes on the drive gearing of the drums, a safety brake on each car which operates when the hauling ropes fail, and an emergency car to take off the passengers of a stalled car. The safety brakes consist of spring-operated wedge jaws which engage the track cables. Spring power was the only means available for actuating these brakes, since the steep gradient made reliance on gravity action impossible. The brakes are thrown into action when either one or both of the hauling ropes breaks, the actuating device being contained in the equalizer bar by which the hauling ropes are attached to the car.

The profile of the rock along the line of the incline is quite concave, the upper part rising nearly vertically. The only place where the cars could foul the ground surface would be the upper end, and therefore at this point the station framing is extended forward in a steel cantilever construction (Fig. 5), whose outer end carries the fastenings of the standing ropes and the sheaves for the running ropes, so that the path of the car is kept well clear of the ground.

The two standing ropes of each incline are placed 3 ft. apart, vertically one above the other and not side by side; this minimizes the disturbing effect of oscillations. The curve of the cables changing as the load moves along them, their terminal angles also change, and at the upper or fixed end this is taken care of by a ball-jointed socket, fitted with rollers to make its motion as free as possible (Fig. 1). These supports are mounted between the webs of the horizontal upper chords of the cantilever, being fastened by pins as may be seen in the drawing.



A SIDE VIEW OF THE WETTERHORN CABLEWAY IN OPERATION.

At the lower station the track cables bear a tension weight, acting on both cables of the pair by an equalizer. The sketch Fig. 2 is a diagram of this connection; the normal position of the equalizer is represented by full lines, while the dotted lines represent the position assumed when one cable stretches more than the other. It will be seen that through the construction of the equalizer the cable having greatest stretch is automatically relieved, by transferring a larger share of the weight to the other cable. When this occurs, of course, the cable carrying the heavier tension will also assume a correspondingly larger share of the load of the car. It is to be remarked that the cables do not directly lead over the small guide sheaves shown, but terminate in lengths of pin-and-link chain which leads over the sheaves to the equalizer.

The haulage ropes, also in duplicate, are disposed horizontally side by side, 5½ ft. apart. At the car they are socketed to clevises pinned to the ends of a horizontal equalizer beam, whose middle pin is fastened to the car. The three pins of this beam are not in a straight line, the middle pin being to the rear of the line of the end pins, so that, as in the case of the tension weight of the standing ropes, a relieving action takes place whenever one rope lags behind the other. The rope that is in advance then takes a greater share of the total tractive pull, and thereby is pressed tighter into the grooves of its sheaves, as a result of which it will tend to run slower and work back to equal position with the other rope.

At the upper station the hauling ropes are deflected by 10-ft. guide sheaves into a horizontal line, and thence pass back to the winding drums. Both ropes of each pair lead to the same drum, and their guide sheaves are therefore set at suitable angles with the vertical, in opposite directions, to converge them to the drum.

The hauling ropes are 1⁹/₁₆ ins. in diameter, composed of six strands of 15 wires, Lang lay. The breaking strength of each is 96,000 lbs., while the working tension is only 5,500 lbs. The track ropes are locked-coil ropes 1¾ ins. in diameter, of 96 wires, with a gross breaking strength of 340,000 lbs. per rope, against a maximum working tension of 30,500 lbs.

The winding machinery comprises two 12-ft. horizontal rope drums, placed side by side in the upper station. The two running ropes from one trackway lead around the drum on its side, then twice around the group of two drums, and over the other guide sheaves down the other trackway. Each drum has on its periphery a circle of gear teeth, engaged by a pinion whose vertical shaft is driven by bevel gearing from a longitudinal brake shaft. On this are mounted (1) an automatic brake, set in action whenever the current is cut off, and (2) a hand brake for

emergency use and to hold the cars at top and bottom of their travel. The automatic brake is also actuated by a speed governor, whenever the cars attain an excessive speed of travel. It can also be thrown into action by the operator whenever desired.

The safety brakes on the car are designed to stop the car by gripping the track ropes when either of the hauling ropes breaks, but may also be tripped manually by the operator on the car. The mechanism of the brakes is sketched diagrammatically in Fig. 4. The drawing represents only the carrier truck, from which the car itself is suspended by four hanger rods attached to a single pin near the center point of the truck (Fig. 3). The truck consists of two side-plates between which are journaled four 24-in. grooved wheels, two running on the upper rope and two on the lower rope. The length of wheel-base is 67 ins.

The horizontal equalizing lever at the front of the truck, to which the hauling ropes are fastened, is in two lateral halves, as seen from Fig. 4, pivoting separately on the pin which fastens them to the truck. Under the pull of the hauling ropes, the two half levers are held forward against the pressure of a spring A so that their heels abut, and the equalizer is virtually solid; but if the tension in either rope or both ropes should fail, the spring A forces them apart. As they separate, the circular rack B attached to one leaf of the equalizer rotates pinion C on the other leaf, and, the pinion having a screw thread cut on its shaft, the nut D is pulled downward. This motion is transmitted through a lever E, bell-crank lever F, and rod G, tripping the latch H which holds rods I I, and allowing the tension spring T to rotate the pins K K by means of the attached crank arms. The pins K carry eccentrics which close the wedge jaws J upon the track ropes. Meanwhile, however, the crank arm of the lower eccentric has struck the end of bell-crank M, which in turn pulls a second bell-crank lever N, thereby throwing the cross-rod P upward and unlatching two catches Q Q which restrain the compression springs R R. These springs, seated against a fixed rear abutment, force the two pivoted levers S S against the wedge jaws J, and, by driving the wedges into their casings, clamp the jaws upon the ropes with considerable pressure. The friction due to this pressure gives the braking action, which is said to be sufficiently powerful to bring the car to rest in a travel of less than one foot.

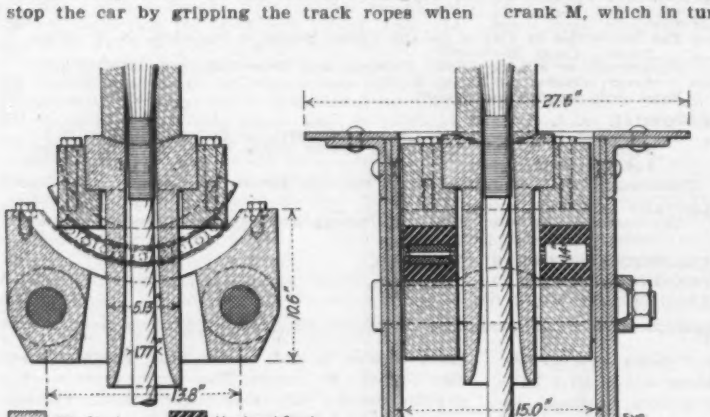


FIG. 1. ROLLER-BEARING PIVOT ANCHORAGE OF TRACK CABLES AT UPPER STATION OF WETTERHORN CABLEWAY INCLINE.

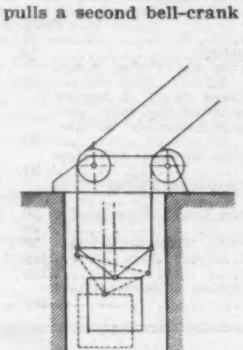


Fig. 2. Diagram of Tension Weight and Equalizer at Lower End of Track Cables.

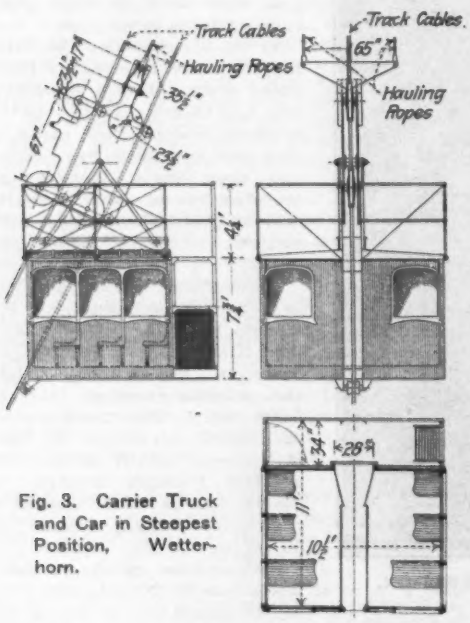


Fig. 3. Carrier Truck and Car in Steepest Position, Wetterhorn.

The essential idea underlying the brake mechanism, it will be seen, is separating the spring action into two parts, one the take-up of the necessary slack in the brake jaws, and the other the actual brake-pressure action. Thus the springs R which produce the braking pressure, need have only a very small path of movement.

The mechanism can be reset, releasing the brakes, by manual means, the attendant being provided with special tools for the purpose. Also, the brake can be tripped manually, by a brake handle on the operator's platform of the car, as already mentioned.

The car has a capacity of 16 passengers, 8 seated and 8 standing. Its weight empty, including carrier truck, is 9,000 lbs. The landing at the stations is alongside the car, connecting with the transverse gangway at the front end (Figs. 3 and 6).

The emergency or relief car runs on the main track cables, but is attached to an independent hauling rope wound on a drum with hand and motor drive independent of the main drums. This car, constructed as light as possible, and capable of holding only three or four persons, is intended for use when the regular cars are stalled between stations. The relief car is then lowered down to the stalled car, and takes off its passengers two or three at a time.

The machinery of the cableway is supplied with power from a 2,400-volt single-phase line from a power plant at Grindelwald. A converter at the lower station transforms it to 800-volt direct current, which supplies either the winding motors (which are at the upper station) or a 74-ampere-hour storage battery at the lower station. The winding motor of the auxiliary or emergency car is a small single-phase motor, which can be operated from the transmission line, i. e., it does not rely on the converted and storage battery.

The design and construction of the entire cableway is the work of the L. von Roll Iron Works in Berne, Switzerland. The arrangement of the track cables and equalizer tension is according to Feldmann's patents.

Passenger Cableway Carrier at Mt. Ulia, Spain.

Another passenger aerial cableway, similar in purpose to the Wetterhorn cableway described above but not nearly so bold in design, has been built connecting two mountain resorts on Mt. Ulia, near St. Sebastian in Spain. From an article in Le Génie Civil, June 5, 1909, p. 105, we are able to present a few details of the construction of this transporter.

One end of this line is near the terminus of an electric railway, which is much used in tourist travel, but the other has heretofore been nearly inaccessible, although a most desirable viewpoint for the sightseer. The new cableway then is used most entirely by visitors and used extensively, as there were some 13,000 passengers during the year 1908. The line is 920 ft. long with a difference in elevation of the two ends of 92 ft. This grade of 10% places the Mt. Ulia carrier in an entirely different class from that at the Wetterhorn, though the system of transportation is of the same general type.

In general the Mt. Ulia carrier consists of one car which is drawn back and forth across the gorge, traveling on one set of cables and being hauled by another set. The essential principles of the system are the number of cables employed so that the rupture of one cable will not endanger the cableway and the device for ensuring constant tension in the cables regardless of the load on the car.

The cableway consists of six cables in two sets of three, one on each side of the suspended car. Each cable is attached, separately, to a fixed anchorage at the lower station and, at the upper station, passes around a sheave to a counterweight. The cableway is thus balanced by the counterweight and the varying weight of the car, depending upon its load, does not change the tension in each cable, but merely varies the deflection of the cableway. So also if by chance one of the six cables should break the weight of the car would be thrown on the other five cables and the deflection would slightly increase but the tension in the cables would remain practically the same.

In the accompanying figure is shown a drawing of the car used on the cableway. From this it will be seen that there are six wheels which travel on the six cables, all outside of the car so as to prevent accident in case of breakage and separated by about 8 ins., so that in case the car jumps the cableway, each cable except the outside one will catch between the wheels on the axle and keep the car from falling. The carrying cables each are ¾-in. in diameter, formed of six strands of seven wires, with a net section of 2 sq. ins. Their ultimate tensile strength is 170,000 lbs. per sq. in., but they are stressed to only about 53,500 lbs. per sq. in., that is a safety factor of 3.

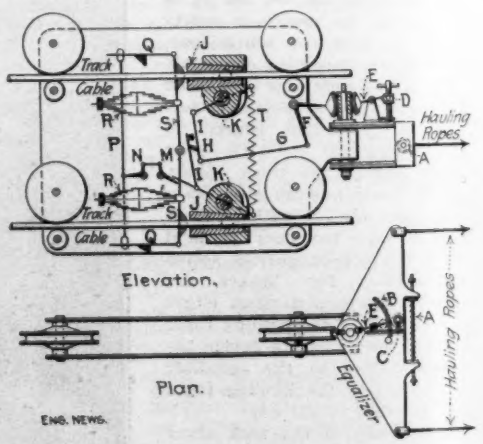


Fig. 4. Diagram of Safety-brake Mechanism on Carrier Truck, Wetterhorn.

Hauling is done with an endless cable driven from an electric motor at the lower end of the

cableway and provided with a counterweighted sheave at the upper end to care for the adjustment. This cable has a section of about 1 sq. in. and a rupturing strength of 236,000 lbs. per sq. in. It is subjected to a stress of 40,000 lbs. per sq. in., a safety factor of 6. The stations at either end are of structural steel columns well anchored into a masonry base.

The car itself is shown at the bottom of this page. It is 11.8 × 3.6 ft. in plan and will hold 12 or 14 passengers. It is suspended from a "traveler" in which the principle of the bicycle wheel is followed, that is a steel-tube arched top connected to a center by wires in tension. From this center the car is suspended by similar radial wires. On the main axle, which is the base of the arched tube, the six carrying wheels are keyed and to this same axle the hauling ropes are connected. With a full load the car weighs about 3,850 lbs. As the counterweight is 10,900 lbs. for each cable, it will be seen that the weight of the car cannot affect the deflection very greatly.

As the grade of the cableway is so small there is not very much danger to be apprehended from a car getting from under control. However, there are two brakes provided, one automatic under excessive speed and one worked by the operator in the car. There is also provided a safety car which can be run out to the main car in case it is stalled in the middle of the span.

This carrier was designed and erected by Senor Torresy Quevedo.

Fig. 6. Car Under Way, near Lower Station, Wetterhorn.

Organization for Prevention of Accidents to Workmen in the United States Steel Corporation.*

From the early organization of the subsidiary companies of the United States Steel Corporation, special departments to deal with accidents to their workmen were organized. Their casualty departments have devoted themselves not merely to the settlement of claims, but have given constant and careful attention to the prevention of accidents. Every accident has been exhaustively investigated to determine its cause. Regular inspections and reports have been instituted, rules put into force and warnings emphasized.

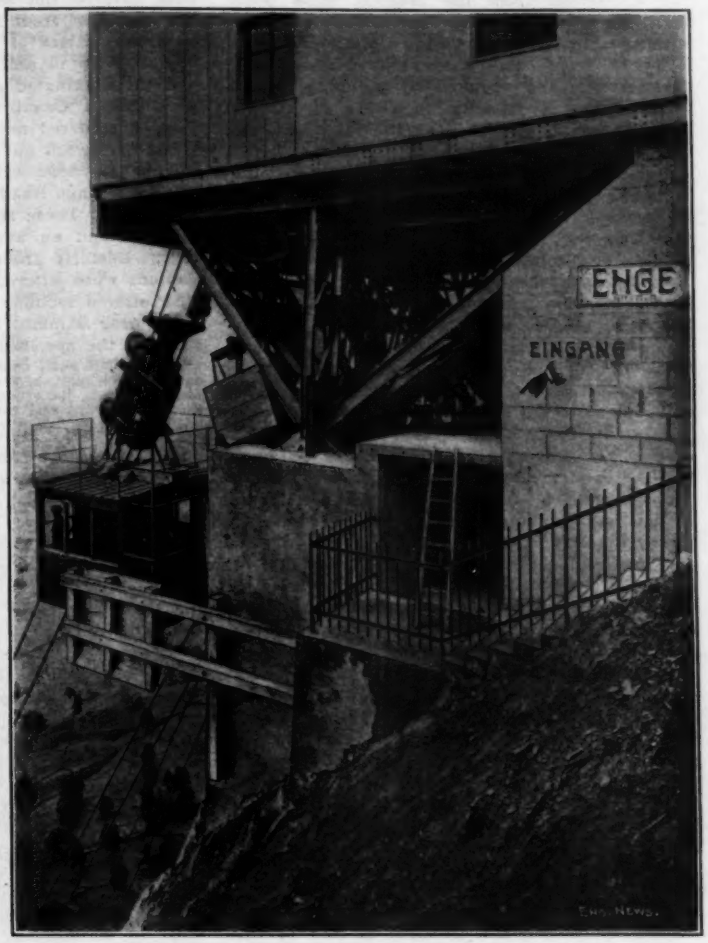


FIG. 5. UPPER STATION OF WETTERHORN CABLEWAY; CAR AT LANDING.

At a meeting held at the office of the United States Steel Corporation in May, 1906, two days were given to the discussion of problems connected with accidents to the workmen. Two years later, in April, 1908, a second meeting of the managers of casualty departments of the subsidiary companies was held in New York. Again, two days were devoted to the discussion of problems connected with accidents to workmen. As a result of consideration during these two years, there was evolved a plan for a Central Committee of Safety to act independently of any of the casualty departments. This committee was to complete and perfect a plan for inspecting, on its own account, the different plants and works of the subsidiary companies, with reference to the best methods of preventing accidents and safeguarding employees. In addition, the committee was to act as a clearing-house in obtaining and disseminating information and suggestions tending toward the prevention of accidents and safeguarding of employees.

*From a paper by Dr. W. H. Tolman read at the 22d convention of the International Association of Accident Underwriters.

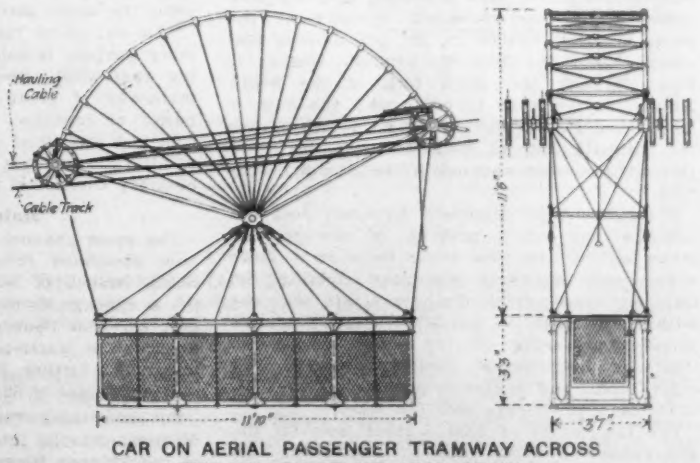
This committee put into operation immediately a most effective system of independent inspections, selecting men familiar with the machinery and operations of the different subsidiary companies and sending them to inspect the mills and plants. They report directly to the Safety Committee. Their reports are exhaustive, taking up each building in the plant and covering it in detail. They call attention even to the smallest sources of danger—worn floors, material piled carelessly and windows which should be cleaned to give better light; their comments cover even loose planks which workmen have left where they might fall; railings, ladders, footwalks and set screws are given the most careful scrutiny. Their reports and recommendations are gone over with care by the Safety Committee and are then sent to the proper representative of the company operating the plant in question. The committee requests the company to submit, within thirty days, a return showing what action has been taken to carry out the recommendations of the inspector; or, if objection is made to any recommendations, on what grounds. At the next meeting of the Safety Committee, these returns are taken up and discussed in detail. Where objection has been made to any recommendations and the reasons for such objection do not seem to the committee sufficient, the representative of the company concerned is requested to appear and explain the matter. Whenever it seems necessary, the committee, or one or more members, delegated for that purpose, makes a personal inspection of the plant with regard to any points in dispute.

In six months, the committee has had 37 of the largest plants thoroughly inspected! It has received and considered no less than 2,600 recommendations made by the inspectors. More than 92% of these recommendations were accepted and complied with by the companies interested. Less than 8% required any additional discussion.

This Safety Committee is now endeavoring to standardize those safety devices which are in use upon machinery common to large numbers of different plants. Heretofore, each subsidiary company has worked out its own method of guarding flywheels, gears, electric switchboards and similar sources of danger which exist at all large mills. It is hoped thus to insure the use of only the most approved and effective safeguards, and by familiarizing the superintendents and foremen with these safeguards, to bring about their ready adoption everywhere by operating men themselves, even without the request of the safety inspectors.

THE OLD BRIDGE AT AYR, in Scotland, celebrated in the poetry of Burns, has recently been entirely renovated and strengthened. The bridge, a series of four masonry arches of 53 ft. span, was built in the middle ages, possibly as long ago as the thirteenth century, and has been repaired more or less extensively from time to time. Lately, however, the masonry in the arches had so deteriorated that fears were entertained for its safety and timber centering had been placed under three of the spans.

The work of reconstruction, just completed, comprised pointing up the surface of the bridge, construction of concrete cross-walls in the earth fill, underpinning the piers and cutting out and replacing damaged stones. Of these the underpinning of the piers gave the most trouble on account of the permeable earth in which the excavation was made and the consequent frequent flooding from the waters of the river. This underpinning was done by excavating a shaft down through the middle of each pier and from that shaft, at an elevation some distance below the bottom of the piers, running out side cuts which were filled in with concrete flush up against the bottom of the piers. The work of replacing stones and repointing was all done with concrete grout, taking due care to reproduce the appearance of the old masonry so far as possible.



CAR ON AERIAL PASSENGER TRAMWAY ACROSS THE VALLEY AT MT. ULIA, SPAIN.

The Sanitary District of Chicago, and the Chicago Drainage Canal: A Review of 20 Years of Engineering Work.

(With colored map, profile and cross-sections on two-page plate.)

By ISHAM RANDOLPH,* M. Am. Soc. C. E.

The Sanitary District of Chicago is organized under the general law for the creation of sanitary districts enacted by the Illinois legislature in 1889. The first Board of Trustees was elected Dec. 12, 1889, and served (barring resignations) until Dec. 2, 1895. Since that period the regular term of service has been five years, until 1905, when the legislature changed the term to six years.

The primary object of the work undertaken by the Sanitary District is the protection of Lake Michigan (the great reservoir from which the city of Chicago and its urban and suburban neighbors draw their drinking water) from sewage pollution due to the discharge directly into it, or into the rivers which empty into it, of the sewage of the city of Chicago and its aforesaid neighbors. The first work undertaken was the construction of a great canal from Chicago (at Robey St.) to Lockport. That done, the logical sequence was the improvement of the Chicago River by deepening and widening and removing bridge obstructions so as to make it possible to secure an adequate flow of water through it without injury to navigation.

The map, Fig. 1, shows the boundaries of the Sanitary District, together with the locations of the main and auxiliary drainage channels, the pumping stations, water-power plant and other related features.

While the Sanitary District of Chicago has been carrying on its great work, the city of Chicago has been reversing sewers which discharged into the lake and discharging them into the Chicago River, and by building on 39th St., from the lake to the east end of the stock yards slip at Halsted St., a conduit 20 ft. in diameter. Along Stony Island Av. and the lake shore, from 73d St. north to 39th St., the city has completed an intercepting sewer increasing in diameter from 12½ ft. at the south end to 16 ft. at the north end.. This intercepts the sewers which previously discharged into the lake. It leads to a 20-ft. conduit on 39th St., extending from the lake to the east end of the stock yards slip (Chicago River) at Halsted St.

At the lake end the city has constructed a pumping plant with four sewage pumps, two having each a capacity of 75 cu. ft. per second, and two having each a capacity of 250 cu. ft. per second. These pumps are to be operated by the Sanitary District of Chicago. The District has erected as a part of the same plant two pumps having each a capacity of 667 cu. ft. per second (40,000 cu. ft. each per min.) to pump lake water. The total pumping capacity of the plant, namely, 120,000 cu. ft. per minute, discharges into the 39th St. conduit, whence it flows through the south fork of the South Branch of the river to unite with the flow of 480,000 cu. ft. per min. in the river and to give the ultimate flow of 600,000 cu. ft. per min. through the main channel of the Sanitary District.†

What has been described, however, does not embrace the whole problem of sewage and water-supply. On the south there is a large urban and suburban population fouling the Calumet River, which discharges into the lake within 3⅝ miles of the Hyde Park four-mile water-supply crib. On the north, beyond the limits of the original Sanitary District, still other urban and suburban populations are discharging their sewage into the lake.

The Legislature of 1903 enacted laws for the annexation of these adjacent territories. On July 14, 1903, this legislation became operative and the original Sanitary District, which contained 185 sq. miles, was enlarged by the annexation of the North Shore District (78.6 sq. miles, and the Calumet District, 95.48 sq. miles). Thus the total area of the Sanitary District today is 358.08 sq. miles. The topography and hydrography of the North Shore District precludes a gravity channel and therefore it is proposed to cut a channel from the lake at some point north of Evanston southward to a connection with the north branch of the Chicago River at Lawrence Ave.* The water to flow through this channel must be supplied by pumping, and a plant having a capacity of 60,000 cu. ft. per minute will be erected near the lake and will be operated by the Sanitary District.

Besides the 60,000 cu. ft. of water per min. to be pumped into the above described North Shore Channel, it will receive the discharge of 35,000 cu. ft. per min. from the Lawrence Ave. conduit, now completed. This conduit is 16 ft. in diameter and takes its water-supply from Lake Michigan. The pumping station is located adjacent to the Chicago, Milwaukee & St. Paul Ry., east of Evanston Ave., 2,400 ft. from the lake. It contains one screw pump with a rated capacity of 589 cu. ft. per sec., and three centrifugal pumps for sewage; one of these is rated at 37½ and each of the other two at 125 cu. ft. per sec. Should these four pumps be operated at their maximum capacity, the total discharge would be 52,710 cu. ft. per sec. This conduit and pumping plant was erected and paid for by the city of Chicago, but will be operated and maintained by the Sanitary District of Chicago.†

The topography and hydrography of the Calumet district admit of treatment that will secure a reversal of the current of the Calumet River and a gravity flow therefrom into the main channel of the Sanitary District through the depression known as the Sag Valley. Surveys have been made and a channel partially located which will accomplish the purpose. The tentative plans for this channel contemplate that it shall be 70 ft. wide at the bottom in earth and 90 ft. in rock, with side slopes in earth of 3 on 5, and a depth of 22 ft., below hydraulic grade line.‡

A suit has been begun in the U. S. Circuit Court to determine the right of the Sanitary District of Chicago, an agent of the State of Illinois, to reverse the direction of flow of the Calumet River and take from Lake Michigan the volume of water necessary for the purposes of this channel. Work on this project is being held in abeyance until the court decides the respective rights of the United States and the State of Illinois.

The work of the Sanitary District has created valuable possibilities in the way of water power development, and the same legislature which passed the annexation laws enacted a law which enabled the Sanitary District to realize in part these possibilities by giving it authority to develop the water power at Lockport.

This outline of the work shows that the primary purpose is sanitation, and that in attaining that vital object it provides an artificial waterway of great utility and develops water power of immense value. Sanitation, navigation and industrial development are the visible results of the vast expenditure made by the Sanitary District of Chicago.

Main Channel.

The main channel of the Sanitary District is now completed from its confluence with the South Branch of the Chicago River, at Robey St., in Chicago, to the controlling works at Lockport (in Will County), Ill., a distance of 28.05 miles. The water-power extension (built later and noted further on) adds 4.30 miles to this, making a total of 32.35 miles.

For the opening of the channel, water from Lake Michigan was let into the main channel by way of the Chicago River and through the auxiliary channel which connects the main channel with the west fork of the South Branch, on Jan. 2, 1900. It took 13 days to fill the channel. On Jan. 17, by permission of the Governor of the State of Illinois, the bear-trap dam at the controlling works at the end of the channel was lowered, and the westward flow of water from the lake commenced. Beyond the controlling works, the construction completed by the District covered the work necessary for conducting the flow from the channel in connection with the waters of the Desplaines River down the declivity to and through the city of Joliet, and the making of such changes in the Illinois & Michigan Canal as the new conditions developed rendered necessary.

The first work puf under contract in the Main Channel in 1892 extended southwest from the Willow Springs Road. (See Figs. 2 and 3 on inset sheet.) These sections were numbered 1 to 14; and had an average length of nearly one mile. Easterly from Willow Springs road, the sections were lettered from A to O (omitting J). The lettered sections are, except for a short distance near Summit, entirely in glacial drift, defined in the specifications thus:

> Glacial drift shall comprise the top soil, earth, muck, sand, gravel, clay, hard pan, boulders, fragmentary rock displaced from its original bed and any other material that overlies the bed rock.

Sections 1 to 14 were put under contract in July, 1892; those from A to F, late in 1892 and early in 1893; and those from G to M (inclusive) in December, 1893. Sections N and O were put under contract May 2, and Section 15, Aug. 27, 1894. Earth was first broken on "Shovel Day," Sept. 3, 1892, on the rock cut below Lemont.

The Desplaines River is a stream of wide fluctuations, with no constant and reliable fountain supply. During some seasons its whole discharge would pass through a 6-in. pipe; at others its volume reaches 800,000 cu. ft. per minute, when it rolls majestically along, flooding the whole valley. Such being the situation, control of this stream was a condition precedent to the successful prosecution of the work upon the main channel. This control has been secured by the outlay of over $1,000,000 (exclusive of bridges) in constructing what is known as the "river diversion channel."

About 13 miles of new river channel had to be excavated parallel with the location of the main drainage channel, and about 19 miles of levee built to divorce the waters of the Desplaines watershed from the channel which is to receive the waters of Lake Michigan and pass them on to the Mississippi River by way of the lower Desplaines and the Illinois Rivers. The width of the river diversion channel on the bottom is 200 ft.; side slopes, 1 on 1½; grade, generally 1.2 per 1,000. (See Fig. 4, on inset sheet.)

At the head of this river diversion it was necessary to provide a safety valve in the form of a spillway, to allow surplus water to flow toward Chicago, pending the completion of the work necessary for carrying the entire floodwaters of the Desplaines through Joliet. This spillway is a concrete dam capped with cut stone, and having its wings faced with stone masonry. It is 397 ft. long, and its crest is 16.25 ft. above Chicago datum (this datum is referred to the low water of Lake Michigan of 1847, and is 579.61 ft. above sea level at Sandy Hook). No water flows over this spillway until the water passing the water gage above it reaches 300,000 cu. ft. per min.

This spillway now has been raised to an elevation which prevents any water from flowing over it at any time.

The principal cross-sections of the canal are shown in Figs. 5 and 6, on the inset sheet.

The cross section of the earth sections from A to E inclusive, a distance of 5.3 miles, is 202 ft. on the bottom; side slopes, 2 on 1. This section extends for about 500 ft. into the west end of F and then reduces to 110 ft. on the bottom, preserving the same side slopes for a distance of 7.8 miles. The explanation of this change of cross sections is as follows: Throughout the rock sections, and those sections in which there is a preponderance of hard material, or where rock may appear, the section adopted is designed according to law for a flow of 600,000 cu. ft. of water per min., which means provision for a population of 3,000,000 people. The narrower channel provides for the flow of 300,000 cu. ft.

*Consulting Engineer for the Sanitary District of Chicago (and for fourteen years Chief Engineer), First National Bank Building, Chicago.

†The intercepting sewer system and the 39th St. pumping station were described in our issues of May 28, 1903; Nov. 9, 1905, and Sept. 10, 1908.—Ed.

*Engineering News, Feb. 19 and Jan. 8, 1903; July 30 and Oct. 29, 1908.

†Engineering News, Sept. 10, 1908.

‡Engineering News, Feb. 9 and June 9, 1905; Jan. 31, 1907.

per min., or for about the present population of Chicago. The enlargement of the narrow channel can be made by the easier methods of excavation, such as dredging, whenever the needs of the city require it.

The grade throughout the lettered sections is 1 in 40,000 (0.025 per 1,000), and the bottom of the channel at Robey St. is 24.448 ft. below datum. The numbered sections, from No. 1 to No. 6 inclusive, are underlaid with solid rock. The width of the bottom, in rock, is 160 ft. Walls of masonry laid in cement have been built upon the rock surface to a height of 5 ft. above datum. Sections 7 to 14, inclusive, are in solid rock; the width at bottom is 160 ft., and the sides are vertical. The prism was taken out in three stopes with offsets of 6 ins. on each side for each cut, making the top width 162 ft. The grade in rock is 1 ft. in 20,000 (0.05 per 1,000).

Section No. 15 is also in rock and its cross section is enlarged at its south end so as to form a "windage basin" in which large vessels may be turned around. The controlling works are located on this section. These works consist of gates and a movable bear-trap dam by which the flow of water from the main channel into the tail race (which is to deliver the outflow into the Desplaines River) can be controlled.

This river below Lockport follows the trough of the valley down a steep declivity to the canal basin in Joliet. The fluctuations in Lake Michigan, by varying slope of water surface, will be felt at the controlling works. Provisions have been made to meet these fluctuations within a range of 5 ft. above datum and 12 ft. below, or an extreme oscillation of 17 ft. The fall from datum at the controlling works to the level of the upper basin is about 42 ft. in a distance of about 4.3 miles.

The controlling works comprise seven sluice gates of metal (with the necessary masonry bulkheads) and one bear-trap dam. The sluice gates may be considered as a modification of what is known as the Stoney gate type. The gates have a vertical travel of 20 ft. on openings 30 ft. wide. The bear-trap dam has an opening of 160 ft. and an oscillation of 12 ft. vertically. This dam is essentially two great metal leaves hinged together and working between masonry bulkheads. The down-stream leaf is securely hinged to a very heavy foundation, and the up-stream leaf is so placed as to present a barrier to the water. This structure is operated by admitting water through properly constructed conduits (controlled by valves) beneath the leaves. To raise the crest of the dam, water is admitted from the up-stream side, and the discharge shut off until the desired height is obtained. Then the valves are adjusted so that the volume of water beneath the leaves shall be constant. To lower the crest, the water beneath the leaves is drawn off until the desired height is reached, when the valves are again arranged so as to maintain a constant volume of water.

All the bridges on the main channel are movable structures.* There are six bridges for public highways. One was built for the use of the Southwest Boulevard and Western Ave. It has double roadways, one for heavy and the other for light traffic. There are seven railway bridges, one being an eight-track rolling-lift structure, with a channel span of 120 ft. One is a four-track swing bridge, and the others are double-track structures. The bridges on the walled and solid rock sections of the channel are all "bob tail" (or with arms of unequal length) counterweighted structures, with pivot piers on the right bank, and the long arms spanning the entire channel, thus avoiding any obstruction to the flow from center and protection piers. These bridges conform to the heaviest modern specifications. The entire weight of the iron and steel used in their construction was 22,862,454 lbs.

Although all of the bridges on this channel are movable structures, yet the law allowed the District to keep them closed and operated as fixed structures for a period of seven years dating from Jan. 17, 1900. At the expiration of that period they were to be equipped with operating machinery and go into service as movable bridges. This has been extended to 1909. When this is done the channel will be a free waterway, navigable for any craft drawing less than 22 ft. of water.

The work of the District south of the controlling works consisted of straightening, widening and deepening the Desplaines River, to give it a flowage capacity of 1,500,000 cu. ft of water per min. This involved, in the city of Joliet, the rebuilding of dam No. 1 and the removal of dam No. 2 (both belonging to the Illinois & Michigan Canal), the removal of the Adam dam, the rebuilding of lock No. 5, and the removal of the guard lock. The stone arch bridge at Jefferson St. has been removed to make way for a steel structure of greater span and of width equal to that of the street. The Cass St. bridge also gave place to a modern steel structure of greater span and width. From Lock No. 5 to Jefferson St., a massive concrete retaining wall has been constructed, extending from Cass St. to Jefferson St. At Jackson St. a great deal of costly excavation has been made to admit of an extensive water power development, which is the property of the state.

The total amount of excavation involved in the construction of the main channel is 26,693,000 cu. yds. of glacial drift and 12,265,000 cu. yds. of solid rock, or an aggregate of 38,958,000 cu. yds. To this must be added the material excavated from the river diversion; glacial drift, 1,810,652 cu. yds.; solid rock, 258,659 cu. yds.; total river diversion, 2,069,311 cu. yds. The work between Lockport and Joliet, including the controlling works, involves 1,201,724 cu. yds. of excavation. The grand total for the main channel, river diversion and Joliet project was 42,229,035 cu. yds. All of this work is now completed, and in addition thereto 457,777 cu. yds. of retaining wall and bridge masonry have been built. The retaining wall is all laid in cement mortar. The rock when broken up expands about 80%, and therefore the volume of the rock spoil banks was nearly 22,542,580 cu. yds. The whole volume of spoil (earth and rock) if deposited in Lake Michigan in 40 ft. of water, would make an island one mile square, with its

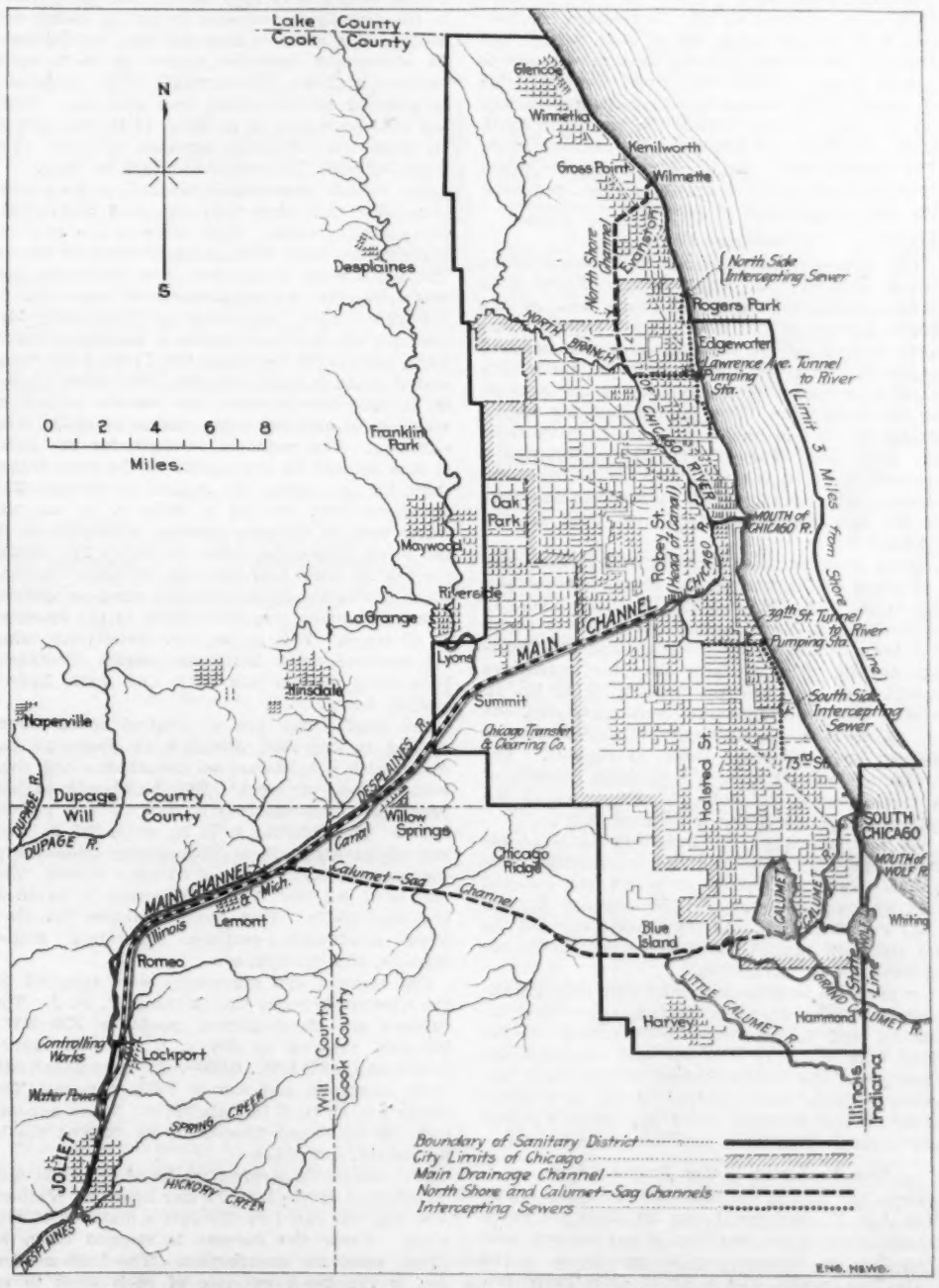


FIG. 1. GENERAL PLAN OF THE CHICAGO DRAINAGE CANAL AND THE SANITARY DISTRICT.

(This plan shows also the auxiliary works: 1, The North Shore channel [under construction]; 2, the proposed Calumet-Sag channel; 3, the North side and South side intercepting sewer systems, and their tunnels connecting them with the river.)

*While designed as movable bridges they have not yet been equipped with operating machinery, and the eight-track rolling-lift bridge is to be replaced with a new structure fitted with machinery.—Ed. Eng. News.

surface 12 ft. above the water line. In addition to these quantities, the work of the main channel extension and water-power development involves 105,000 cu. yds. of masonry and concrete.

The largest amount of material excavated in any one month, since the work began, was in August, 1894; 1,291,688 cu. yds. of glacial drift, and 413,164 cu. yds. of solid rock. But the largest estimate returned was for the month of June, 1895, amounting to $743,365, representing the excavation of 959,074 cu. yds. of glacial drift, 550,500 cu. yds. of solid rock, and 13,799 cu. yds. of masonry laid in cement.

During July, 1894, 74,800 cu. yds. of solid rock were removed by the contractors for Section 8, a record which, up to that period, had probably never been equaled since man began to quarry stone. After that time, however, this remarkable feat was eclipsed by the contractors for Section 14, who, during the month of April, 1895, excavated 86,400 cu. yds. of solid rock. The average daily output of rock for the month of June, 1895, reached 21,366 cu. yds., requiring the use of eight tons of dynamite.

Chicago River.

The distance from the mouth of the Chicago River to Robey St. (the junction of the main drainage channel) with the west fork of the South Branch of the river) is six miles. From Lake St. to Robey St. the channel is to be widened to 200 ft. and given a depth of 26 ft., for a mid-channel width of 100 ft., shallowing up to 16 ft. at the dock lines. The standard docks are of timber secured to anchor piles 38 ft. back from the dock face. The District has constructed a concrete dock on the west side of the river extending from Randolph St. to Madison St. This is the first permanent dock ever built on the Chicago River.

Much work has been accomplished in executing the plans of the District for river improvement. Up to May 31, 1908, 488,650 sq. ft. of land had been acquired for widening, nearly all of which has been excavated by dredging and the frontage docked. The dredging thus far aggregates 2,935,691 cu. yds. and the docking 10,822 lin. ft. Eleven bascule bridges have been completed, one of which is a double-track railway bridge of 275 ft. span between points of support. The bridge at Ashland Ave. is a trunnion bascule, of a type invented by John W. Page; all of the others are of the Scherzer rolling-lift type.

An adjustment of the questions at issue between the city of Chicago and the traction companies has been arrived at which has resulted in lowering the tunnels at Washington St. and near Van Buren St., and the abandonment of the La Salle St. tunnel. The beneficial results are appreciated by navigation.

In order to accommodate the flow through the proposed Lawrence Ave. conduit (mentioned already), and to improve the condition of the river, the Sanitary District has enlarged the channel of the North Branch of the river between Belmont and Lawrence Aves. to a width of 90 ft. and a depth of 12 ft. below Chicago city datum. This work was completed in 1907.

The Lockport Water Power Plant.

From the date of the lowering of the bear-trap dam, Jan. 17, 1900, until Aug. 30, 1907, the water flowing through the Sanitary Canal escaped over that dam or through the Stoney gates at the controlling works, and a great potentiality ran to waste. The legislative enactments of 1903 make it possible to stop this waste. The plans for water power development were adopted and on Oct. 7, 1903, bids were opened covering the extension of the main channel as a waterway and power canal for four miles south from the controlling works. Contracts were let and a vigorous prosecution of the work was entered upon. For two miles this extension was between walls and massive clay embankments, heavily faced with riprap. The power-house was located at the end of this stretch, where a drop of 34 ft. was available under average conditions.*

The channel above the power-house is of varying width and nowhere less than 160 ft. All of the area available was taken into the channel so as to impound water for lockage purposes and so minimize possible fluctuations of head due to taking water into the locks. The structures at the end of this first stretch of 10,604 ft. are ice fenders, penstocks, power-house, movable dams and canal lock. The channel below the power-house is 336 ft. wide where the tail water discharges, narrowing in 850 ft. to 160 ft. and a minimum depth of 19.7 ft. These dimensions are held for 6,000 ft. to a junction of the Desplaines River Channel where the depth is only 10 ft., but the total width is 400 ft.

POWER PLANT.—The power plant is located on the west side of the channel, and the entrance to the forebay is protected by an ice fender consisting of a massive concrete wall carried upon 14 submerged concrete arches of 19-ft. span, built on a skew. The entrance to the penstocks is guarded by the usual iron gratings. There are nine penstocks 32 ft. wide, 74 ft. long and 28 ft. high from floor to intrados of arch. The walls between the penstocks are 6 ft. thick.

The central penstock is devoted to the exciter equipment and when fully equipped will contain three exciter units. Two of these are now installed; they have 30-in. Jolly-McCormick wheels. The installation in the four west penstocks was made by the Wellman-Seaver-Morgan Co., of Cleveland; each unit consists of six Jolly-McCormick 54-in. wheels upon a horizontal shaft. This shaft is 12 ins. diameter, 71 ft. 5 ins. long, and is made in three sections. The outer section is of open-hearth steel, the middle section of nickel steel and the inner section of nickel steel annealed. The requisite strength for the parts is thus secured by the quality of the steel rather than by increasing the weight of metal. The speed of these wheels is 163⅓ r. p. m.; the water used at 0.8 gate opening is 100,000 cu. ft. per min., developing 5,360 El. HP. The shafts revolve in oiled bearings, the oil being in constant circulation by means of a pumping system. Inspection tubes give free access to the bearings at all times. This is the first installation using six turbines on a horizontal shaft. Contracts have been let for the fifth and sixth hydro-electric units.

The draft tubes are of original construction, molded in concrete, designed to discharge the water with a minimum of disturbance and consequent loss of head. The bulkheads of the penstocks form the north wall of the power-house. The building is 70 ft. wide, 385 ft. long and 47 ft. high. It is built wholly of concrete, the superstructure being of concrete blocks. The roof is of red tile. The architecture is dignified, and impressive. This house contains the electrical machinery, exciters, generators, transformers, switchboard, etc.

The exciters and generators were supplied by the Crocker-Wheeler Co., of Ampere, N. J. The exciters are direct-current machines, 350 KW., 250-volt, running at 300 r. p. m. The generators are 4,000-KW., 6,600-volt, three-phase, 60-cycle machines, and run at 163⅓ r. p. m. The rotors are 18 ft. 2 ins. diameter. These generators are connected directly to the turbine shafts by suitable couplings.

The current is stepped up to 44,000 volts and transmitted to the transformer house at Western Ave. and the canal in Chicago, a distance of 29½ miles. There the current is stepped down to 12,000 volts for distribution. The transmission line is the finest example of such work to be found anywhere. The poles are 60 ft. high, built of steel angles and lattice bars, galvanized. These are two steel cross arms, also of riveted lattice construction and galvanized, carrying six insulators of umbrella type. Aluminum wire is used for transmission, seven strands in each cable, the equivalent of 000 B. & S. gage. The spacing of the insulators keeps the cables 72 ins. apart. The poles are placed 350 ft. apart on straight lines, and where there are changes of direction they are nearer together.

MOVABLE DAMS.*—There are two movable dams adjacent to, and east of, the power-house. They were designed by Mr. E. L. Cooley. Their simplicity is admirable and their operation most successful. One of these dams is an outlet from the forebay; it has a length of 12 ft. on the crest. The other one, 48 ft. long on the crest, is an outlet for the channel. The vertical range of these dams is 14 ft.

LOCK.—The canal lock built is of the dimensions prescribed by the legislature of 1903; 22 ft. wide, 130 ft. long between miter sills and with 12 ft. of water over the sill. This is a concrete structure and is the highest lift lock yet built. The lift will at times be as high as 40 ft.; the mean lift will be about 36 ft. There are some novel features about this lock in the way of gate operating mechanism and filling and emptying valves. Space has been reserved for the building of a lock of proper dimensions for the larger navigation of the deep waterway.

BUTTERFLY DAM.—The creation of the water power resulted in holding a great body of water at an elevation of nearly 40 ft. above the level of a large area in Joliet, about two miles away. While all of the structures which hold this water up are of ample strength to insure the safety of the people down-stream, yet the authorities of the Sanitary District were willing and anxious to make "assurance doubly sure," and to that end they caused the butterfly dam to be built at the entrance to the water power extension. This device affords a prompt and effectual method of shutting off the water in case of accident, but under normal conditions is no barrier to navigation.

This dam, which is described below, is the only one of its kind in existence. Its efficiency and ease of operation have been abundantly demonstrated. This dam went into service at 3 a. m. Aug. 27, 1907, when the cofferdam which held back the waters of the main channel was blown up. On Aug. 30, at 1.45 p. m., the filling of the channel below the dam was commenced, the 12 valves in the dam being opened for that purpose.

A Description of the Butterfly Dam.

In Fig. 7 is shown the general design and arrangement of the butterfly dam described in the foregoing article for shutting off the power section of the canal. The dam resembles a large steel lock gate, pivoted at the center instead of at the middle.* It lies normally in the center line of the channel, leaving a navigable pass on each side. When in this position its ends are protected by concrete piers, and a fixed bridge is built between these piers to hold the top pivot of the dam. The bottom pivot is in a steel frame let into the rock bottom of the channel to a depth of 40 ft. In the dam are sets of small valves (A and B) each 6 ft. 4¼ ins. long and 4 ft. 1 in. high.

Ordinarily the dam is open under the service bridge or brace span. To close the channel, the dam is started by rack and pinion mechanism which throws it into the current. At this time the six valves (A) are opened and the six valves (B) are closed, so that the current acts against a larger closed area on the (B) side than on the (A) side. The dam is then swung across the stream into the position shown in the plan, thus closing the channels. To open the channel again for navigation, the valves (B) are opened and the valves (A) are closed. This throws the greater pressure on the (A) side which swings the dam back to this open position. The operating mechanism is at the center of the bridge and the motive power is electricity.

A tunnel for the use of the operator extends from the west abutment to the north pier. When the dam is in service and the lower channel is empty, the pressures are 1,739,000 lbs. on the top pivot and 3,776,000 lbs. on the bottom pivot. This bottom pivot is 32 ins. diameter. The dam is 184 ft. long and 30 ft. 1 in. high. The weight of dam proper is 710 tons. The total weight of steel in the structure is 1,080 tons.

The North Shore (or Evanston) Canal.

This canal has its lake connection in the southeast corner of Wilmette and its course from thence is southwest for a distance of 2¼ miles. When the westerly line of Evanston is reached the channel parallels Kedzie Ave. south to Devon

*Engineering News, Jan. 12, 1905, and Jan. 18, 1906.

*Engineering News, Sept. 12, 1908.

*Engineering News, Sept. 12, 1908.

Ave. There it veers to the southeast and connects with the North Branch of the Chicago River at Lawrence Ave. Its total length is 8½ miles. This channel is 40 ft. wide at bottom. The depth of water will be 12 ft.; the width at water line, 80 ft. The water supply for this channel will be secured by pumping from Lake Michigan. The pumps, which are to be electrically operated, will be located in a suitable station at the lake end of the channel. The volume to be pumped is 60,000 cu. ft. per min. The sewage of Evanston and other north shore towns is to be diverted into this channel. This channel will permit of barge navigation, and access to the lake at the north end will be afforded through a lock.

Summary of Dimensions of Main Channel.

By ordinance the main channel of the Sanitary District begins at Lake St. The plans under which the Chicago River has been improved require a width of 200 ft.; a depth of 16 ft. at dock lines, increasing to 26 ft. at 50 ft. out from the dock; the middle 100 ft. is 26 ft. deep below the hydraulic grade line with Lake Michigan at datum. The artificial channel begins at Robey St., six miles from the mouth of the Chicago River. The first division of the artificial channel is 7.8 miles long (ending at Summit); its minimum depth is 22 ft.; bottom width, 110 ft.; side slopes, 1 on 2. The second division extends from Summit to Willow Springs. 5.3 miles. It is 202 ft. wide on the bottom, with side slopes of 2 on 1. The third, or rock, division extends from Willow Springs to the Controlling Works, 14.95 miles; bottom width, 160 ft.; sides vertical with

THE SANITARY DISTRICT OF CHICAGO.

SUMMARY OF NET RECEIPTS AND EXPENDITURES FROM ORGANIZATION TO DEC. 31, 1908.

RECEIPTS.

Taxes collected		$40,081,826
Bond Account—(Bonds outstanding):		
First issue	$400,000	
Second issue	750,000	
Third issue	900,000	
Fourth issue	1,200,000	
Fifth issue	280,000	
Sixth issue	320,000	
Seventh issue	200,000	
Eighth issue	190,000	
Ninth issue	550,000	
Tenth issue	600,000	
Eleventh issue	1,500,000	
Twelfth issue	1,300,000	
Thirteenth issue	1,050,000	
Fourteenth issue	1,125,000	
Fifteenth issue	1,125,000	
Sixteenth issue	1,776,000	
Seventeenth issue	472,000	
Eighteenth issue	472,000	
Nineteenth issue	500,000	
Twentieth issue	1,000,000	
Twenty-first issue	850,000	
Twenty-second issue	2,000,000	
Twenty-third issue	1,000,000	
		19,560,000
Interest on bank balances		413,286
Electrical Department interest account		2,294
Tax levy, 1896 (warrants outstanding)		1,932
Dock and land improvement and rental account (rents of land)		85,584
Chicago & Great Lakes Dredge & Dock Co.		2,143
Western Stone Co.		331
James O. Heyworth		500
Total receipts		$60,147,883

EXPENDITURES.

Right of Way, North Branch of Chicago River	$17,150.00	
South Branch, Chicago River	4,890,575.93	
North Shore Channel	910,554.79	
Main Channel & River Divers.	3,106,172.46	
Calumet-Sag Channel	11,208.65	
South of Joliet	10,476.56	$8,946,138
River Diversion, construction	$1,008,014.13	
Bridge construction, river divers.	142,486.20	
Main Channel construction	19,365,964.43	
Bridge construct'n, Main Channel	2,070,796.46	
Controlling works, Lockport	331,253.65	
Bridge const., controlling works.	7,873.35	
Joliet project	1,308,251.12	
Bridge construction, Joliet project	274,486.76	
Chicago River, dredging, docking, etc.	2,213,915.03	
Bridge construct'n, Chicago River	2,999,884.60	
Illinois & Michigan Canal improvement at Bridgeport	77,016.08	
Thirty-ninth St. pumping station	229,702.00	
North Shore Channel construction	175,168.82	
Bridge construction, North Shore Channel	48,764.10	
Calumet-Sag Channel construct'n	437,006.81*	
Lowering La Grange and Kampsville dams	21,033.08	
Raising roadway of Brandon's Bridge	5,890.68	
Water power development at Hickory Creek	6,570.70	
Warehouses Nos. 1 and 2 on Western Ave.	10,214.96	30,734,292
Electrical Department		3,278,216
Capitalization and maintenance of bridges	$403,354.60	
Maintenance of highway bridges	26,573.75	
Maintenance account	217,495.08	647,423
Interest on bonds	$9,120,934.00	
Interest on tax warrants	468,453.69	
Discount and interest on loans	11,695.66	9,601,083
Taxes on land, Cook County	$82,777.61	
Taxes on land, DuPage County	1,559.83	
Taxes on land, Will County	49,570.61	133,908
Engineering Department	$2,562,377.68	
Clerical Department	212,104.47	
Law Department	1,195,751.72	
Treasury Department	49,702.85	
Police Department	442,245.45	
General account	1,095,051.09	5,557,233
State Inspection of Main Channel		33,075
Land damages		105,090
Marine damages		15,473
Personal injuries account		5,075
City of Chicago		16,360
Bridgeport Pumping Works		90,388
Machinery and tools account		98,770
John M. Ewen Co.		3,643
Joseph J. Duffy		101,308
Weir, McKechney & Co.		22,118
Hayes Bros. Co.		490
Strobel Steel Construction Co.		56
A. F. Shaw & Co.		13
Total expenditures		$59,390,159
Emergency funds in the hands of the President and department officials	$24,900 00	
Cash in hands of I. J. Bryan, Clerk	343.39	
Balance in hands of Charles L. Hutchinson, Treasurer	732,479.94	757,723
		$60,147,883

*The item of "Calumet-Sag Channel Construction" in the list of expenditures calls for a word of explanation. While no construction work has been done on this channel, Sections 1, 2, 3 and 4 of the Water Power Extension were made larger than they would have been otherwise, in order to provide for the flow from the future Sag channel. The excess cost of this work, due to the extra capacity, is charged to the account of the Calumet-Sag Channel.

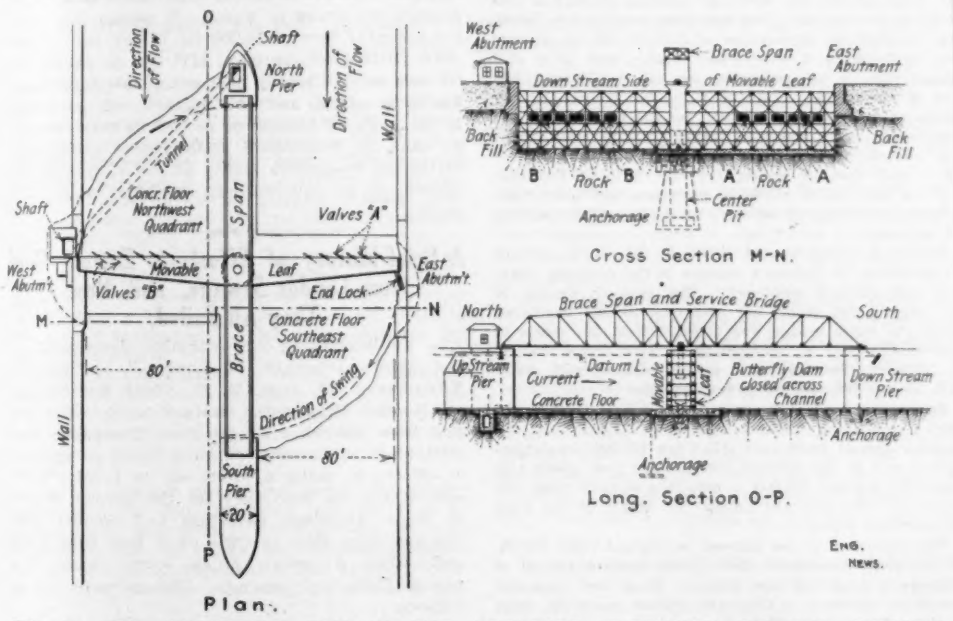


FIG. 7. THE BUTTERFLY DAM IN THE LOCKPORT EXTENSION OF THE CHICAGO DRAINAGE CANAL.

two offsets of 6 ins. each, giving a width at water line of 162 ft. At the Controlling Works there is a fan-shaped basin with an extreme width of 502 ft. From these works to the power plant, two miles, the channel is of irregular width, nowhere less than 160 ft. Below the power-house, a width of 160 ft. is maintained in the channel.

Methods of Working.

On the earth sections some novelties were introduced. On Sections L and M, specially constructed cars were loaded by steam shovels and drawn by steam hoists up a steep incline to a proper height, where they ran on to a tipple and were automatically dumped. Each incline was equipped with two 4-yd. cars, which loaded and dumped alternately. On Sections I and K, the contractors erected bridges spanning the spoil bank at proper height, their supporting piers being carried on trucks which traveled on tracks parallel with the channel. From the channel end of the bridge, an inclined track ran down into the cut. In connection with this device, two 8-yd. cars were used; these were successively loaded by steam shovel, drawn up the incline on to the bridge by a steam hoist, and then automatically dumped and immediately returned to the pit. An output of 100 cu. yds. per hour was probably sustained by this combination of devices.

On Section H, a conveying machine, designed by Hoover & Mason, was constructed on a mammoth scale. It was essentially a bridge spanning the channel with cantilever arms projecting far enough beyond on each side to overhang the spoil area. On this structure were mounted the necessary sprocket wheels and other machinery for carrying a series of steel pans, which formed the conveyor. The machine was mounted on trucks traveling upon tracks parallel with the channel, and its capacity was 500 cu. yds. per hour. This capacity, however, was that of the conveyor only, the arrangements for excavating the earth and loading the conveyor were never perfected to an extent which secured recognition for the device as one of the successful inventions applicable to great public works.

On Section F, the material was taken from the steam shovel by cars fitted with pneumatic dumping apparatus, the power for which was supplied from the locomotive. The engineman operated these dump cars just as he would apply the air brakes. Sections A, B and a portion of C are located in the old channel of the Desplaines River, and were overlaid with muck to a considerable depth. This muck was removed by hydraulic dredges. Each of these dredges had a capacity of about 2,500 cu. yds. in 10 hours, and this output in solid matter represents about 8% of the capacity of the pumps. One great advantage of the hydraulic method of removal is that the material can be removed to any desired dumping ground within a distance of 3,000 ft. without adding anything to the contract price of the excavation.

On those sections which are partly in earth and partly in rock, all of the usual methods of removing earth were employed, varied to suit the peculiar conditions or to meet the ideas of the contractors doing the work. On Section No. 6, a large amount of muck had to be removed, and a very ingenious contractor improvised a hydraulic dredge at a small cost, and did the work at a very moderate expense.

On the rock sections the sides were cut down vertically by channeling machines, and the merits of several devices were satisfactorily demonstrated on this work. Rock drills were used in breaking up the rock between the channelers, and on the sections which were best

planned these were worked from a central power station by compressed air. The top lifts were removed by the use of carts and small cars, the traction for the latter being usually supplied by steam hoisting engines. The lower lifts were taken out by the use of cableways, high power derricks and cantilever conveyors.

The cableways as first constructed were not very successful, but experience gained upon this work resulted in improvements from time to time, until by the adoption of a simple improvement, devised by Mr. H. C. Locher, one of the contractors, they were brought to a stage of efficiency which made them worthy competitors of the cantilever conveyors. The high power derricks used upon two of these sections did not come up to the expectations of the builders, and their use was confined to the machines already in place. The revolving derricks on Section 14, after a great deal of costly experimentation, developed considerable merit. The cantilevers are probably the most perfect devices now known for hoisting and disposing of material from rock cuttings such as these.

Powers and Resources of the District.

This channel is constructed under the general law for incorporating sanitary districts, enacted by the Illinois Legislature in 1889. The Sanitary District of Chicago comprises all of the city of Chicago, together with about 167 sq. miles of Cook County, outside of the city limits, which will be directly benefited by the improvement. The population of the District is about 2,000,000, and the equalized assessed valuation of real estate and other property for the year 1907 subject to taxation, was over $490,000,000.

The Trustees are elected by popular vote and form an independent organization separate and distinct from the municipal government of Chicago. They may levy and collect taxes for carrying on the work intrusted to them up to 1% of the assessed value of the taxable property within the corporate limits of the District, as the same shall be assessed and equalized for state and county taxes of the year in which the levy is made. By an amendment passed in 1895, this power was increased to 1½% for a period of three years, beginning with the year 1895. Subsequently, as it appeared that the District would not have sufficient funds to complete the work, the Trustees procured the passage of an act in 1897, extending the levy of 1½% for two years more, or until and including the year 1899. They may issue bonds to the extent of 5% of the value of the taxable property of the District as determined by the current assessment for state and county taxes previous to the issue of said bonds.

As mentioned already, the General Assembly of the State of Illinois, in addition to the annexation law, conferred upon the Sanitary District the explicit authority to develop the water power at Lockport.

The District has issued $32,140,000 of bonds, all payable in currency; $8,000,000 are 5% bonds, $6,450,000 are 4½%; $390,000 are 3½, and $17,300,000 are 4% bonds. These run for from 1 to 20 years, except that the 3½% bonds run for 20 years from date. Each year 5% of the issue must be paid off and retired; of the total amount of bonds issued the sum of $12,182,000 have been retired, leaving $19,958,000 outstanding Jan. 31, 1908. The taxes afford a revenue sufficient to pay the interest on these bonds, to pay off and retire 5% of the issue each year and leave a surplus to apply upon the current obligations of the District incurred for construction and other purposes.

The Legislature of 1903, which permitted the District to create and sell water power, has given a source of revenue which will materially lighten the burden of taxation.

Deep-Waterway From Lake Michigan to the Mississippi River.

The work performed by this District constitutes nearly 66% of the entire cost of creating a channel from Chicago to the Mississippi, which would be navigable for the largest boats which will be able to ply between St. Louis and New Orleans, after the present plans for the improvement of the Mississippi will have been completed. The creation of such a channel seems to be inevitable; a commercial necessity sooner or later to be recognized and undertaken by the general government, which must carry out the enterprise, if it is ever executed.

The Results of the Sanitary Work.

The foregoing description shows what has been done in the way of construction and the cost thereof.

A knowledge of what has been accomplished by this work is of interest. What have the people of Chicago and the Sanitary District got in return for this vast expenditure? First of all, what has been the effect of this work upon the health of Chicago? Let the Health Commissioner reply to that question:

Communities show health progress in proportion to the degree that they develop a sanitary conscience, to the extent that the principles of sanitary science and preventive medicine are applied.

It is to the increasing application of sanitary science and preventive medicine that Chicago owes the marvelous changes that have been wrought in its death rate in the last 15 years, changes that now entitle this city to the distinction of rating as the most healthful large city in America, if not in the world.

It is true that Chicago enjoys many natural advantages, such as of climate, of location on the shores of a great body of fresh water, and of a population made up of young, vigorous and healthy people. But these are but factors that have made the application of sanitary science and preventive medicine more rapidly and pronouncedly effective. We had the same advantages of climate, of location and of population 30 years ago when the death rate was 60% higher than now.

It is to sanitation and preventive medicine then, that we must ascribe the credit for making Chicago a safe town to live in. It is due especially to sanitation, which has involved an expenditure of $100,000,000 in securing and distributing a pure water supply, and of a still larger sum, in the aggregate, for lifting Chicago's feet out of the original mud and mire; for raising the city grade so as to secure drainage; for the construction and maintenance of a sewerage system; for the main drainage channel and sanitary waterway; for a magnificent park and open-air space; for free bathing facilities; and for many other works of sanitation unrivalled (considering the youth of the city) by any other municipality in history.

The most beneficial and useful of the many sanitary undertakings of Chicago's citizens is the drainage channel and sanitary waterway. The sanitary quality of the city's water supply has been continuously improving since the city's sewage was diverted from the source of our water supply by the opening of the drainage channel in January, 1900, and later by the building and operation of the intercepting sewer systems.

An improved water supply has put typhoid fever in the list of vanishing diseases. In 1891, Chicago had the highest typhoid death rate (173.8 per 100,000 population) of any city in the civilized world. Last year (1908) this rate was 15.6 per 100,000, a reduction of more than 91% from the 1891 rate and among the lowest of the large cities of the world.

The reduction in the amount of typhoid fever stands as the most remarkable fact in the sanitary history of Chicago during the last decade. From the appended statistical summary of Chicago's typhoid mortality, some striking figures are obtained.

Comparing the average typhoid death rate of the nine pre-channel years with the average of the nine years that the channel has been in operation, we find a reduction of 63%, from 64.1 to 23.5 per 100,000 of population. If the rate of the pre-channel period had obtained during the last nine years, the period of time that the channel has been in operation, there would have been 11,148 typhoid deaths, or 7,127 more than actually occurred in that time.

Regardless of population increase, there has been an actual reduction in the number of typhoid deaths amounting to 3,410, a total of 4,021 in the last nine years as against 7,431 the preceding nine years.

To a limited extent the 39.5% reduction that has taken place in the diarrheal disease death rate in the same period of time, may also be attributed to the improved water supply.

The Chicago experience fully substantiates the statement of Rideal that "no living being can be healthy while the products of his vital action are allowed to accumulate round him."

What material advantages have accrued to the city, the state and the nation? The Chicago River has been improved as a navigable stream. A width of 200 ft. is assured throughout the South Branch, and a midstream depth of 26 ft. A channel which will float any vessel navigating the Great Lakes has been extended inland 36 miles. The first and most costly link in the Lakes-to-the-Gulf Waterway has been built without cost to the nation.

DEATHS FROM TYPHOID FEVER IN CHICAGO
Before and After the Opening of the Drainage Canal.
(Channel Opened Jan. 17, 1900.)

Before.			After.		
Years.	Deaths.	Death rates per 100,000 of population.	Years.	Deaths.	Death rates per 100,000 of population.
1891	1,997	173.8	1900	337	15.8
1892	1,489	124.1	1901	509	23.9
1893	670	53.5	1902	801	44.1
1894	491	37.5	1903	588	31.4
1895	518	37.9	1904	373	19.3
1896	751	52.6	1905	329	16.1
1897	437	29.3	1906	370	18.1
1898	636	40.8	1907	376	17.8
1899	442	27.2	1908	338	15.6
Total deaths of the 9 years "Before"					7,121
Total deaths of the 9 years "After"					4,021
Actual reduction, regardless of population increase "After"					3,410
Average death rate of the 9 years "Before"					64.1
Average death rate of the 9 years "After"					23.5
Reduction in each 100,000 yearly "After"					40.6
Per cent. reduction in the death rate "After"					63.3

The conditions in the Desplaines and Illinois Rivers have been greatly improved. The Illinois River is the greatest producer of food fishes in the United States. Prior to the introduction of water from Lake Michigan in the volume now flowing, the Illinois River in the summer season became so foul that fish died by the thousand and added to the foulness of the river. Now the constant flow of cool lake water has conduced to the increase of fish life and the fish catch has become an important industry and element in the wealth of the state.

The flow of this water down the declivity from Lockport to Utica means that there is a great potentiality going to waste. It means that with the ultimate flow of 14,000 cu. ft. per sec. no less than 140,000 net electrical HP. can be developed. Of this total, Chicago will get 40,000 HP. at its Lockport plant, and the balance will go either to the state of Illinois or to Illinois corporations, as shall be determined by the courts, which must settle the respective rights of the state and the citizen or an incorporated combination of citizens.

A Brief History of Efforts to Extract Gold from London Sewage, and How They All Failed.

In an interesting and valuable description of the "Main Drainage of London," by Maurice Fitzmaurice, M. Inst. C. E., Chief Engineer of the London (England) County Council, which has just been published by the Main Drainage Committee of the Council, we have found an account of efforts to make a profit out of London sewage, which we reproduce for the special benefit of some American agitators and writers who descant from time to time upon how New York and other American cities might make rich profits from their sewage. The extracts are as follows:

The authors of the Metropolis Local Management Act, 1855, seem to have contemplated the possibility of profitable disposal of the London sewage, as there is a provision that the Metropolitan Board may sell or dispose of the sewage and refuse from the sewers as it may see fit, but so as not to create a nuisance (see section 135 of Act).

The notion that sewage might not only be utilized in agriculture, but that it might become a profitable commodity was very prevalent 40 or 50 years ago. The idea of making substantial profits out of the sale of town sewage is now regarded as an illusion. The House of Commons in 1862, and subsequently in 1864, appointed committees to inquire into the question of the utilization of sewage and the latter committee reported favorably thereon.

In 1865, the first year in which both the new sewage outfalls were in operation, the Board concluded an agreement with respect to the sewage of the north side of London, with the Hon. W. Napier and Mr. W. Hope.

Messrs. Napier and Hope proposed to take the sewage at Barking, and to convey it through culverts to the Foulness Sands, near the mouth of the Thames, where it was to be applied to the fertilization of land to be reclaimed from the estuary.

In 1865, an Act of Parliament, called the Metropolis Sewage and Essex Reclamation Act, was passed, ratifying the agreement, and giving to the company to be formed under the Act, the powers necessary for the undertaking.

The company having been formed and a portion of the capital subscribed, a contract was entered into, and the works were commenced. After a time it appeared that the prospects of the adventure were not sufficiently encouraging to lead investors to contribute the necessary funds. The undertaking languished, the works were suspended, and eventually abandoned. The periods mentioned in the original Act, and in an extension Act, having expired, the sum of £25,000 [$122,000] deposited with the Board by the promoters as security for the completion of the works was forfeited. This, it may be mentioned, is the only money the ratepayers of London have received in respect to their sewage, which was once considered to be of so much pecuniary value.

In 1880, the promoters of a scheme of utilization obtained an Act of Parliament, called the Dagenham and District Farmers' Sewage Utilization Act, after having come to an agreement with the Board to take the sewage from the Northern Outfall Sewer. They proposed to pump and convey it through a number of conduits, and to sell it for agricultural purposes in Essex. Previous experience did not lead the Board to anticipate any favorable results from the scheme, and, after the promoters had obtained their statutory powers, the Board heard nothing more of it. As regards the Southern Sewage, the Board considered favorably a tender by Mr. Ellis in 1806 and again in 1867, but owing to the want of financial support Mr. Ellis's proposals fell through and nothing was done.

In 1872 the Native Guano Co. carried out a prolonged experiment at Crossness under the system known as the A. B. C. process, but the Board finally came to the conclusion that there was no hope that the adoption of the process would be of any advantage to the ratepayers.

Even now proposals are still put forward for utilizing the sewage. One recent suggestion was that of an inventor, gifted with perhaps less knowledge but more imagination than his fellows, who proposed to supply the United Kingdom with alcohol from London sewage. Many curious proposals for making use of London sewage have been put before me from time to time by the large army of inventors, but no proposal has ever got beyond the preliminary stage. Several enthusiasts on the subject of the useful utilization of sewage have begged for sample gallons of it at the outfalls, and one even took away a barrelful, but I have never again heard from any of them, and the amount of sewage which they have taken away has made no appreciable diminution in the 335,000,000 [U. S.] gals. a day which are still at the disposal of any one who will take it in whole or in part. The fact of the matter is that the valuable matter, whether alcohol or other material in large quantities of sewage, is very similar to the gold which exists in all sea water, but which unfortunately costs more to extract than it is worth.

Laying a Subaqueous Reinforced-Concrete Pipe with Cast-Iron Flange Connection.

At the Marion, N. J. plant of the Public Service Corporation of New Jersey, there have been recently installed two large concrete suction pipes, which are provided with an elbow and which were each laid in two parts bolted together at a cast-iron flange molded into the concrete coincident with the molding of the pipe. At the time the enlargement of the power-house was projected the merits of various metal and concrete pipes were investigated, and it was decided to use the Lock-Joint Pipe, a reinforced-concrete pipe which has been described in our columns, Dec. 10, 1908, p. 643. This pipe is made up of a series of short lengths of concrete pipe, reinforced with wire cloth or expanded metal. Each length is provided with special bell and spigot ends, which leave a circumferential opening in the inside of the pipe to be filled with concrete after the lengths are joined together.

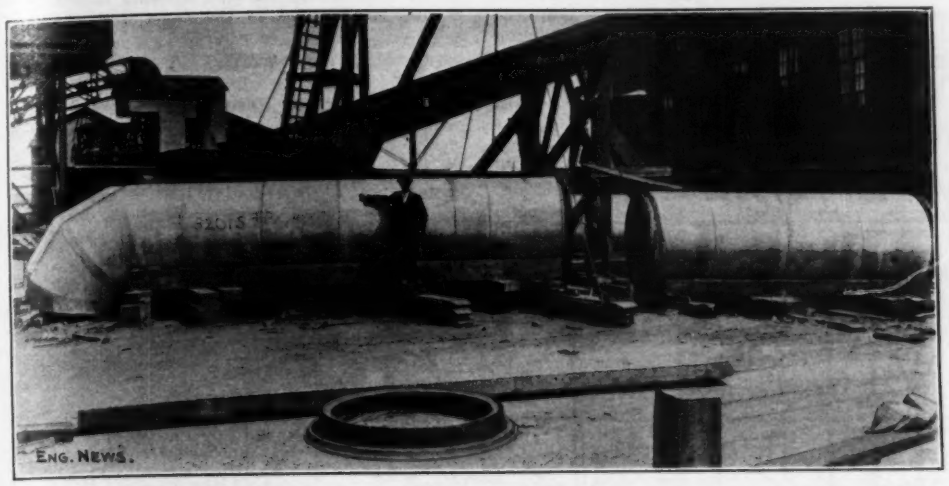


FIG. 1. TWO SECTIONS OF LOCK-JOINT REINFORCED-CONCRETE PIPE BEFORE PLACING AS SUCTION PIPES.

The suction pipes at the Marion plant had to be laid from the intake at the river back through a dock and bulkhead to meet a wrought-iron pipe at the wall of the power-house. It was thought necessary to put the bottom of the pipe 7 ft. 6 ins. below low water, so that there might always be a free flow of the full capacity of the pipe to the wells and, in order to get only clean water, the outer end of the pipe was made in the form of a down-turned elbow. The distance from the intake to the house pipe was about 40 ft.

Excavation was started in the mud in front of the dock and, by taking up the floor, under the dock, where it was found that a large oil pipe running parallel to the bulkhead line, obstructed the free laying of a 40-ft. length of pipe. It was then decided to put the concrete pipe down in two sections and join them with a bolted cast-iron flange. Excavation was then continued under the obstructing pipe and a pile and timber cradle driven in line on which to rest the pipe.

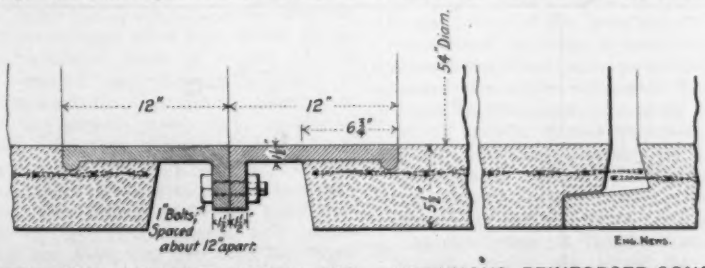


FIG. 2. CAST-IRON FLANGE FOR SUBAQUEOUS CONTINUOUS REINFORCED-CONCRETE PIPE.

The pipe itself is shown in Fig. 1. It is 54 ins. in inside diameter with a shell thickness of 5½ ins. reinforced with triangular mesh wire cloth. The long section is made up of six 4-ft. lengths with a 6-ft. elbow and the short one of four 4-ft. lengths. All the joints in these two sections, including those in the elbow (which is in three pieces and is extra reinforced) were made according to the special inside filled groove joint of the Lock-Joint Pipe Co. (See right-hand side Fig. 2.) Each section was made and joined on the dock, through which it was dropped into position. The detail of the flange connecting the two parts is shown in Fig. 2. It is merely an L-section circumferential plate of cast-iron, placed in the molds at the time of concreting and firmly held in place by the concrete which was set around it. The bolt holes in the flange are about 12 ins. c. to c.

Ten days after the short lengths had been jointed, the pipe was lowered onto the cradle. First the 16-ft. length was lowered at an angle and slid underneath the cross pipe. When this length rested in a horizontal position on the cradle the 24-ft. length was lowered directly through the hole in the wharf to its position, flange against flange of the other length. Divers assisted the placing of these two lengths and saw that the bolt holes of the flanges lined up and then bolted them together. Not only was the connection of the two concrete pipes provided with this bolted flange, but a similar one was placed on the shore end of the 16-ft. section, to which the flange of the wrought-iron power-house pipe was bolted.

Two suction pipes of the type and dimensions described were placed, immediately alongside one another. They are now in position and are working very efficiently with no perceptible leakage.

The design of the pipe is due to Mr. Coleman Meriwether, of the Lock-Joint Pipe Co., New York. The work was carried on under the direction of Mr. J. T. Whittlesey, Chief Engineer of the Public Service Corporation of N. J., by the F. M. Stillman Co., contractors.

PROTECTION OF IRON AND STEEL FROM CORROSION.—A number of metallurgical processes, such as the Bower-Barff and others, have been, from time to time, proposed and exploited for producing an oxidized surface on steel. As far as the writer is aware, none of these have as yet been found practically successful, except for certain special purposes.

The Coslet process is said to consist in immersing the iron in a hot, phosphorized solution containing an iron compound. The surface, it is claimed, is converted into a ferroso-ferric phosphate, which is to some extent resistant to corrosion. Jouve has called attention to the fact that iron containing 20% of silicon is not attacked by acids, and therefore such material should theoretically be unrustable. The author has confirmed this deduction by experiment, and found that iron containing 10% of silicon is almost incorrodible. Unfortunately, such a metal is not easily workable, and has peculiar properties. Since silicon is much like carbon, chemically speaking, it would seem as if it might be worked into the surface of steel by modifications of some of the processes used for case-hardening with carbon. If any one should discover a method for applying a skin of high silicon metal on worked steel it would be a contribution of the highest value to the art of metallurgy and to the world at large. —From a paper by Dr. Allerton S. Cushman, Assistant Director, Office of Public Roads, Washington, D. C., read before the Iron and Steel Institute.

THE BADEN STATE RY., Germany, will haul the traffic of the line from Basel through Schopfheim to Zell and to Säckingen on the Rhine, a total of about 15 miles, by electric locomotives in place of steam. There will be a daily service of 12 express and 51 local passenger trains and 15 to 21 heavy freight trains. The weight of a passenger train there, exclusive of locomotive, is about 230 tons, while the freights approach 500 tons. The average grade between Basel and Zell is 1 in 175 and the maximum is 1 on 100. The new installation will be made mainly by the Siemens-Schuckert Company, though two other concerns have smaller contracts.

Three-phase current at 6,800 volts, 15 cycles, will be taken from a station on the Rhine, near Augst-Wyhlen and converted to 10,000 volts single-phase for the railway line. Ten locomotives have been ordered from the Siemens-Schuckert Company, of a type suitable for hauling both passenger and freight traffic. The locomotive has three center drivers, rod-connected. The combination of drivers is connected through inclined rods at the ends to single-phase motors on the ends of the frame, somewhat after the style of the experimental locomotive built by the General Electric Co., of Schenectady, and shown in Engineering News, May 27. At each end of the locomotive frame is a pony axle. The motors are of a multipolar series type rated at 390-HP. continuous, at 525-HP. for one hour and 800-HP. for short periods of time. The work is described at greater length in London "Electrician" of July 2, 1909.

The Designs for Emergency Movable Dams for the Panama Canal.

The recent accident at the Canadian Lock at Sault Ste. Marie and the prompt shutting off of the flow of water through the open lock by the use of the emergency dam there has awakened general interest in the design of structures of this class.

We present, therefore, the drawings showing the present accepted designs for the movable dams to be built at Panama. They are in general similar to the dams which have been built at the Sault; but the details have been worked out with great thoroughness in view of the magnitude of the task which the structure and its operative parts have to accomplish. Briefly stated, this task is to place a dam across a channel 110 ft. wide with a maximum depth of 50 ft., through which a torrent of water may be moving with a velocity which may be liberally estimated as 25 ft. per second. At the Sault lock, at the time of the recent accident, the maximum velocity of the current in the lock was 15 ft. per second.

The drawings herewith show the general features of the structure and its operating machinery. The method of operation is explained in detail in the following paper, which has been prepared at our request by Mr. T. B. Monniche, Designing Engineer, who has had special charge of the preparation of plans for this dam under direction of Col. H. F. Hodges, of the Commission.

Report on the Emergency Dams of Swing-Bridge Type for the Panama Canal at Gatun and Pedro Miguel.

General Features of Design.

The design, as shown on the accompanying general plan, consists of two vertical cantilever trusses with unequal arms, pivoted on the bank of the canal, and capable of being turned from a position parallel to the same until the long

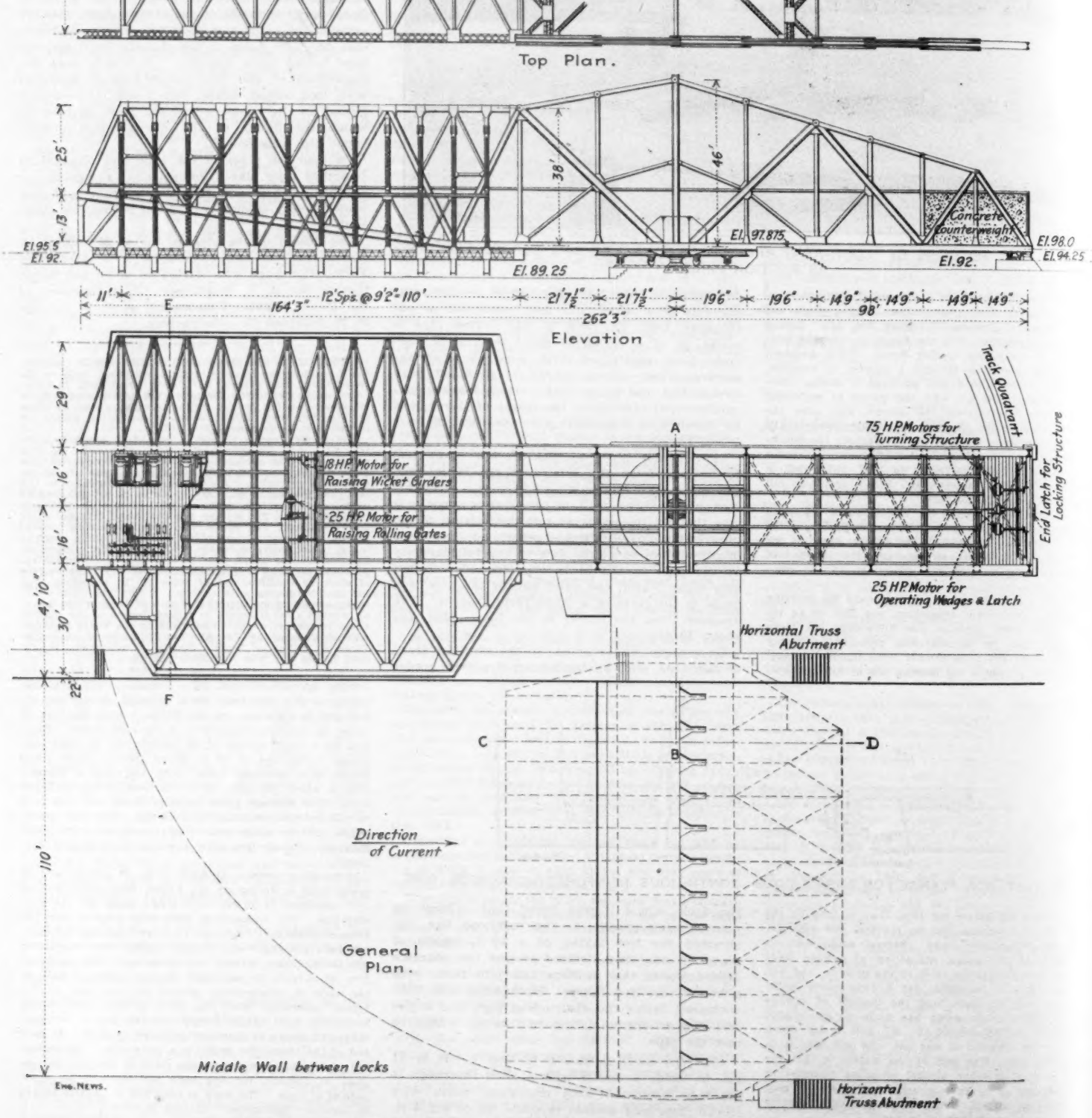


FIG. 1. PRELIMINARY DESIGN OF EMERGENCY DAM FOR PANAMA CANAL LOCKS.

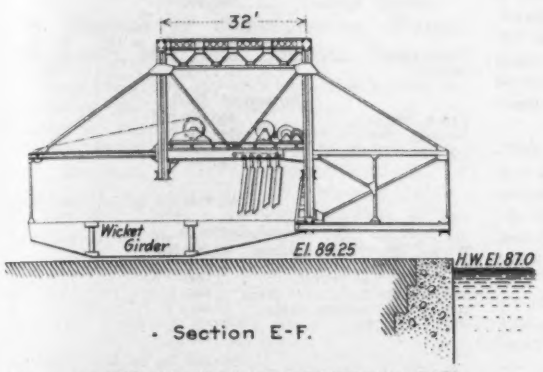
arm spans the channel. This arm carries the wicket girders, rolling gates, and horizontal truss, which may be said to form the dam proper. A framing of heavy girders transfers the load from the vertical trusses to the center pivot.

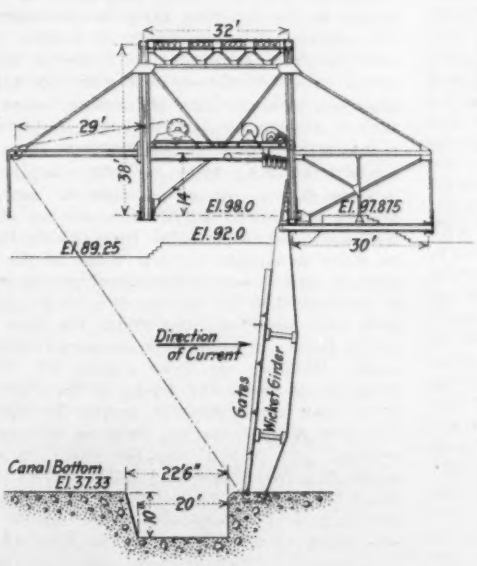
This pivot consists of a large circular casting, imbedded in the masonry, on which rests a lenticular bronze disk between two hardened steel ones. On top of the disks another casting is placed which is fastened securely to the cross girders between the vertical trusses. Eight trolling wheels, adjusted to clear their circular track slightly when the bridge is balanced, are provided to take the overturning effect of a wind pressure from any direction.

The balancing of the whole superstructure about its transverse axis is accomplished by means of a large block of concrete placed on the shorter counterweight arm. The turning is done by means of pinions and rack, driven by electric motors, as in ordinary swing-bridges.

The wicket girders and rolling gates have many features in common with those proposed for the Erie Canal.

In both cases, the girders are pivoted at one end to the supporting superstructure, on pins, about which they are revolved from their original horizontal positions until their lower ends come





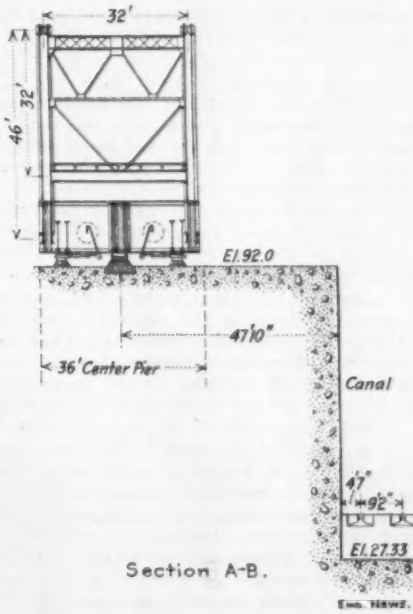


FIG. 2. CROSS SECTION OF EMERGENCY DAM.

in contact with the bottom sill of the canal. The reaction produced by the moving water, and later the static pressure on the gates, are taken at the upper ends of these girders, through a horizontal truss system, to the lock walls, and at their lower ends directly into the masonry sill. The rolling gates are lowered in horizontal rows, closing the canal across its entire width by the depth of each succeeding set, thereby gradually converting the dynamic pressure to a static head, which is the only feasible way of checking the flow in a channel of such large dimensions as the Panama Canal.

On account of the great depth and velocity of current, the following special features, different from all similar designs, have been found necessary. The horizontal truss is placed on the down-stream side of the two vertical trusses, in order to counteract the overturning moment of the long wicket girders, hung in a horizontal position when the bridge is balanced and swinging. A system of booms and sway frames was provided to support these girders and the horizontal truss. The rolling gates are hung vertically between the main trusses and immediately below the floor, and are used in adjusting the equilibrium of the whole structure about its longitudinal axis. They could not be stored directly on the wicket girders, as that would have been entirely impracticable in the present case with a head of water of 50 ft.

Details of Design.

VERTICAL TRUSSES.—The vertical trusses, two in number, carry the whole weight of the superstructure, operating machinery, and concrete counterweight, as well as those vertical forces due to the pressure from the water on the wicket girders as they are being lowered. After full investigation of the various types of trusses, the Warren truss, with subdivided panels, was adopted, as presenting the greatest simplicity of details and rigidity. Its weight was found to be very little in excess of the Pratt pin-connected span, on account of being limited by the spacing of the wicket girders to very short panel lengths. There are fewer changes in chord stresses, and the posts are all secondary members and identical.

The simplicity was carried further by making the top chord of the long arm horizontal, securing the same general outline above the floor, and a uniform slope to all boom supports. The bottom chord is inclined on this arm and the vertical posts of the down-stream truss run through it and down to the suspended horizontal truss. This offers the additional advantage that when the horizontal truss deflects under the water load, it will have less effect on the vertical truss, as the posts will deflect below the chords.

The inclination of the top chord is different on either side of the vertical center post, and is so chosen that the stresses produced in the two inclined center posts are equal, thus insuring identical details for the connection of these posts to the bottom chords, and transferring the same load to each of the two large cross girders over the center pivot. This truss, of the Warren type, while presenting a somewhat unusual outline to the eye, serves its purpose admirably, and allows the simplest of details.

SWAY FRAMES.—At every panel point to which a wicket girder is attached, a very strong system of sway framing is required to take the forces produced by lowering these girders into the current, and also to brace the bottom chords against buckling under compression. Instead of placing the upper horizontal tension member of the sway framing in the same plane as the top lateral system, it was attached to the sides of the vertical posts beneath the top chord. This arrangement eliminates complicated and inefficient details for the connections of the inclined hangers to the top chord.

As the posts of the vertical and horizontal Warren trusses are all of the same width, all sway frames for the long cantilever arm are alike. Trusses of any other system would have required a different sway frame for each width of post, of which there would have been at least three.

LATERAL SYSTEM.—No lateral system could be placed along the lower chord of the long arm of the vertical trusses, on account of interference with the rolling gates when lowered. It was, therefore, placed on the top chord alone. The whole system was greatly simplified by placing the upper horizontal tension member of each sway frame beneath the struts of the lateral system. By this arrangement, and by extending the diagonals over two panels, instead of one, half the number of lateral struts is required, and skew cuts and large splices on every diagonal avoided. On the counterweight arm, the lateral bracing is placed along the lower chord and in the same plane with the force exerted by the pinions in turning the bridge.

FLOOR SYSTEM.—The floor is placed between the two vertical trusses about 14 ft. above the bottom chords at their lowest point. It consists of transverse floor beams, longitudinal stringers and a covering of heavy plank, and carries the machinery for operating and also the gates, which are hung below it. The floor beams, besides carrying these loads, must take the thrust from the horizontal booms used in lowering the wicket girders. These floor beams are of double built-up channel sections, with the bottom flange bent downward at the end near the down-stream truss, so that the roller gate carriages will roll out of the way after they have brought the gates to a position from which they can be lowered.

HORIZONTAL TRUSS.—The function of the horizontal truss is to take all horizontal forces due to moving or static water pressures, for which the vertical trusses are not adapted. It is a complete truss system in itself, suspended from overhanging booms on the down-stream side of the vertical trusses. The panel lengths are limited by the spacing of wicket girders to 9 ft. 2 ins. The subdivided Warren truss has been adopted here for the same reasons that governed in its selection for the vertical trusses and which are mentioned under that heading. Stiff, built-up sections for all members are especially suitable, as the truss always occupies a horizontal position, and the dead loads act at right angles to the plane in which the forces from water pressure are applied.

WICKET GIRDERS.—The wicket girders take the static pressure of the water from the rolling gates and transfer it to the bottom sill and horizontal truss. They were designed with especial view to presenting a minimum exposed surface to the current, thus reducing the force required to lower them. The box shape, with double webs, offers a smooth outside surface to the water, and has great strength in itself, not only laterally, but also in resisting the torsion due to a current that may strike the girder at an angle. Its resistance against torsion has been carefully studied, and found sufficient to withstand the action of a current acting at an angle of 24°, without the use of any bottom lateral system or cross frames. The omission of these greatly reduces the area exposed to the pressure of the current, and admits of considerable independent vertical motion of the girders, due to unequal stretching of the lowering ropes, or obstruction in the pockets at the sill. This latter could only happen in still water, as the cur-

rent, in case of accident, would remove all deposit from the pockets.

By the use of a heavy rail, riveted to the top flange of the girders, the loads from the wheels of the rolling gates are transmitted directly into the wicket girders without eccentricity, and no countersinking of rivet heads along the top surface of the girders is required, which would weaken the whole section. In this manner two decided disadvantages of other similar designs have been eliminated.

Large holes have been provided in the webs for cleaning and painting the enclosed surfaces, thus obviating to a large degree the only disadvantage of a box section. These holes with others communicating through the channel stiffeners, provide ample space for filling quickly when lowered into the water, or draining properly after raising.

ROLLING GATES.—The rolling gates take the direct water load and transfer it to the wicket girders. Each gate is composed of a frame covered with buckle plates, and supported on flanged wheels, which run on rails placed on top of the wicket girders. Each gate is a cantilever span projecting one-half panel on either side of the supporting pair of wicket girders, thus covering two panel widths, with the same bending moment which would occur on a simple span of one panel length. There are five gates for each pair of wicket girders. As now detailed, there will remain an opening 4 ins. wide for the full depth of the dam between each set of gates after lowering, a total of 100 sq. ft. The best method for closing these slots and making the dam water-tight, has not yet been worked out, but it seems as if there would be no especial difficulty in doing this.*

The lower edge of each gate is provided with a triangular nose, composed of a plate, cold-pressed to the shape required, and filled with concrete. This helps in getting the gates down, both by its additional weight and the partial vacuum produced in the moving current, avoids all counter-sinking of rivets between the faces in contact, and makes it possible for each gate to clear the chain-fastening of the preceding gate, by simply notching these plates at these points.

Guides are provided on the brackets of the vertical posts of the truss, so that the gates are prevented from swinging while being lowered, and to insure that they engage the rail of the wicket girders without difficulty or delay. The wheels upon which the gates roll on the rails of the wicket girders are designed with especial view to reducing the friction and taking the large loads from the water pressure. They have flanges which prevent side displacement and a safety guide under the head of the rail to prevent any possible uplift. Any pressure on the side of the rail-head produces only rolling friction, as the gate goes down to position, while in other designs that have been studied, the gates are guided against lateral displacement by stationary guides, producing sliding friction. It has been computed that the gates will go down by gravity without any auxiliary pulling arrangement. The friction of the wheels, on their bronze bushings, would be about 5%, while the weight of the gates themselves would overcome a friction of even 50%.

MACHINERY FOR TURNING.—The whole structure is turned about its pivot by two 75-HP. motors, placed near the end of the counterweight arm, and connected with two pinions moving in a rack of 90°, placed on the masonry. By this arrangement the force at the rack is reduced, and the pinions kept the same size as is used on a double-track railroad bridge of about 300 ft. out to out, where the turning arrangement must be kept on the center pier. The two motors can turn the bridge into position against a wind of 50 to 60 miles per hour in 2½ minutes. With no wind it can be done in less than a minute with both motors, or in two minutes with only one in use. Though the probability of both motors being out of order at the same time is not great, an auxiliary hand-power can be provided without any difficulty.

MACHINERY FOR DRIVING WEDGES.—Between the two 75-HP. motors for turning, is placed one 25-HP. motor for driving the center and end wedges. By having the end wedges on the counterweight arm, near the motor, the length of shafting is reduced, and machinery simplified. All three motors can be operated from one point on the bridge, making it possible to drive the wedges immediately after the bridge is in position and locked. This 25-HP. motor is capable of driving end and center wedges simultaneously in 15 seconds. The locking arrangement is automatic, and is released when the wedges are drawn. It is similar to that used for railroad bridges.

MACHINERY FOR LOWERING WICKET GIRDERS.—The wicket girders are lowered in pairs from their horizontal position by means of wire ropes, attached to each girder. Both drums are fastened to the same shaft and controlled by the same friction band, therefore paying out the ropes equally to each girder.

All girders are lowered simultaneously, thereby distributing the pressure from any side current among all the girders. Also the time for lowering all girders is just one-sixth of what it would be for lowering them in successive pairs. For raising them, one pair at a time, one 18-HP. motor is sufficient. It drives a line shaft which can be thrown into gear, by means of clutches, with any pair of hoisting drums. Each pair of girders can be raised in 6 minutes.

MACHINERY FOR SHIFTING AND LOWERING GATES.—After the bridge is swung and wedges driven, the gates must be successively shifted from their positions when the structure was balanced, to a point from which they can be lowered against the top flange of the wicket girders, and down to their final positions. This is accomplished by having the lowering chains pass over sprockets and under the floor beams to the gates, to which they are permanently fastened. Winding up these chains will pull the gates along the lower flange of the floor beams until they come directly under the sprockets. The horizontal force will then be changed to a vertical pull, which will lift them from their supporting carriages and allow these to roll down the inclined bottom chord, out of the way. The gate is now supported entirely by the lowering chains, and is ready to be lowered to its final position. Two of these chains are used for each gate, passing from individual storing drums over a pair of sprockets connected to one shaft, thus insuring equal lengths of chain to each side of the gate. Each gate has a similar system of sprockets, storing drums and chains, arranged as well as possible in the available floor space. A horizontal row of six gates is shifted over simultaneously, and lowered in the same manner. Each pair of sprockets can be thrown in or out of gear with the main line shaft, through a system of gearing and jaw clutches. One 25-HP. motor furnishes the power necessary to shift and raise the gates, and one friction band controls the lowering of a set of five gates.

On the assumption that the dam will be operated by a gang of well-trained and intelligent men, familiar with each and every step in the operation, it is estimated that the dam can be lowered to close the canal completely in half an hour, and can be raised and removed in two hours. The total number of men required for operating the dam will be as follows:

Laborers on deck	6
Men for friction bands	6
Engineer for motors, operating wickets, & rolling gates	1
Engineer for motors, turning dam and driving wedges	1
Total	16

The total horsepower required for operating the dam is given below:

For operating wedges and latch	25 HP.
For turning structure	150 HP.
Raising wicket girders	18 HP.
Raising rolling gates	25 HP.
Total	218 HP.

MATERIALS USED.—In order to reduce the weight on the center pivot and to avoid excessive thicknesses and consequently long grips of rivets, nickel O. H. steel is used for the vertical and horizontal trusses, wicket girders, and cross girders at center pivot. Rolling gates, lateral, sway, and floor systems are structural O. H. steel, as the sizes are minimum in many cases and could not be reduced by the use of nickel steel.

All castings are of cast steel with the exception of the top and bottom disks of the center bearing, which are to be cast nickel steel annealed, for required strength. Parson's manganese bronze is specified for the center disk, on account of its high ultimate strength and elastic limit. Cut teeth are to be used for all gearing, and shafts are of cold-rolled steel.

ESTIMATE OF WEIGHT AND COST.

Nickel Steel.		
Vertical trusses	620,000 lbs.	
Horizontal trusses	210,000 "	
Wicket girders	460,000 "	
Center bearing girders	110,000 "	
1,400,000 lbs. at 9c.		$126,000.00
Machinery, etc.		
For operating gates	105,000 lbs.	
Chain for operating gates	15,000 "	
For operating wicket girders	108,000 "	
For turning bridges and driving wedges	300,000 "	
528,000 lbs. at 10c.		52,800.00
Wire rope		3,200.00
Motors		7,000.00
Structural Steel.		
Cross frames	400,000 lbs.	
Rolling gates	380,000 "	
Lateral system	60,000 "	
Floor	40,000 "	
880,000 lbs. at 7c.		60,200.00
Steel Castings.		
Wicket girder sill castings	50,000 lbs.	
Center pivot	35,000 "	
Carriages for gates	13,000 "	
Bearing for horizontal truss	4,000 "	
Wheels for rolling gates	38,000 "	
Other Castings	100,000 "	
240,000 lbs. at 5c.		12,000.00
Flooring.		
3-in. planking and nailing strips 24 M. B. M., at $75		1,800.00
Concrete Counterweight.		
700 cu. yds., at $6		4,200.00
		$267,200.00
Engineering and contingencies, 20%		$53,300.00
Total cost of superstructure for one dam.		$310,500.00

Remarks.

The advantages of being able to inspect, paint or repair, at any time, is a decisive point in favor of this type of dam over any submerged structure. It will have a longer life than the ordinary steel bridge, because the loads for which it is designed are gradually applied, and will never be exceeded in the future, and it will be free from the action of smoke and gases. These factors are so destructive to the ordinary steel structure that we seldom have the opportunity to determine what would be its life free from these conditions and under proper care and inspection. Conservative unit stresses have been used throughout the design, and although the problem of handling the gates and wicket girders in a current of 25.5 ft. per second, and such depth as here encountered, is rather complicated, no unusual sizes or sections have been found necessary. The design has been especially studied with regard to simplicity of details and to conform to modern American shop practice, and it is believed that the present design presents a structure of perfect reliability, developed along the lines of the ordinary railroad drawbridge in the United States.

The accompanying estimate, made from preliminary drawings, is believed to be ample to cover the cost of the superstructure and operating machinery.

Respectfully submitted,

T. B. Monniche.

Designing Engineer.

Culebra, Canal Zone, Panama, Feb. 8, 1909.

*Since this report was prepared we understand that a plan has been adopted for closing this gap by the use of iron pipe of about 6 ins. diameter. These pipes, joined up in a long length by internal couplings, such as are used on drive pipe, will be lowered to the bottom and rolled along on the gate until it rolls into and closes the 4-in. gap.

The Slide in the Necaxa Dam.

Since our last issue was published, we have received a section and photograph further illustrating the slide in the Necaxa Dam, described on page 72 last week. The section, which is reproduced herewith, shows that the upper portion only of the clay core went out, the lower part remaining intact. It also shows the gradation of material from the large rock on the exterior to the pure clay in the core. In the light of what occurred, it appears probable that the portion of the fill designated as "Material poroso en parte" (which needs no translation) actually contained enough clay mixed with the broken stone to lubricate the whole mass and make it really a part of the soft core, so far as exerting pressure on the exterior slopes was concerned. Of course, when soft clay is mixed with broken rock in sufficient proportion to fill or nearly fill the voids, the mass loses stability and may flow nearly as readily as the pure clay alone would, while the greater weight of the rock will cause the mortar-like mass to exert greater hydrostatic pressure.

The photograph shows very clearly the interior of the dam after the accident and shows the dried out clay adhering to the steep slopes of the sides as described in Mr. Schuyler's report last week.

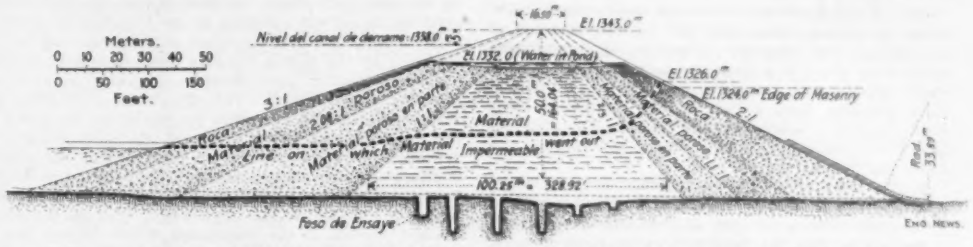


FIG. 1. CROSS SECTION OF NECAXA DAM SHOWING HEIGHT REACHED ON MAY 20, WHEN SLIDE OCCURRED. SECTION IS TAKEN WHERE THE SLIDE WAS DEEPEST.

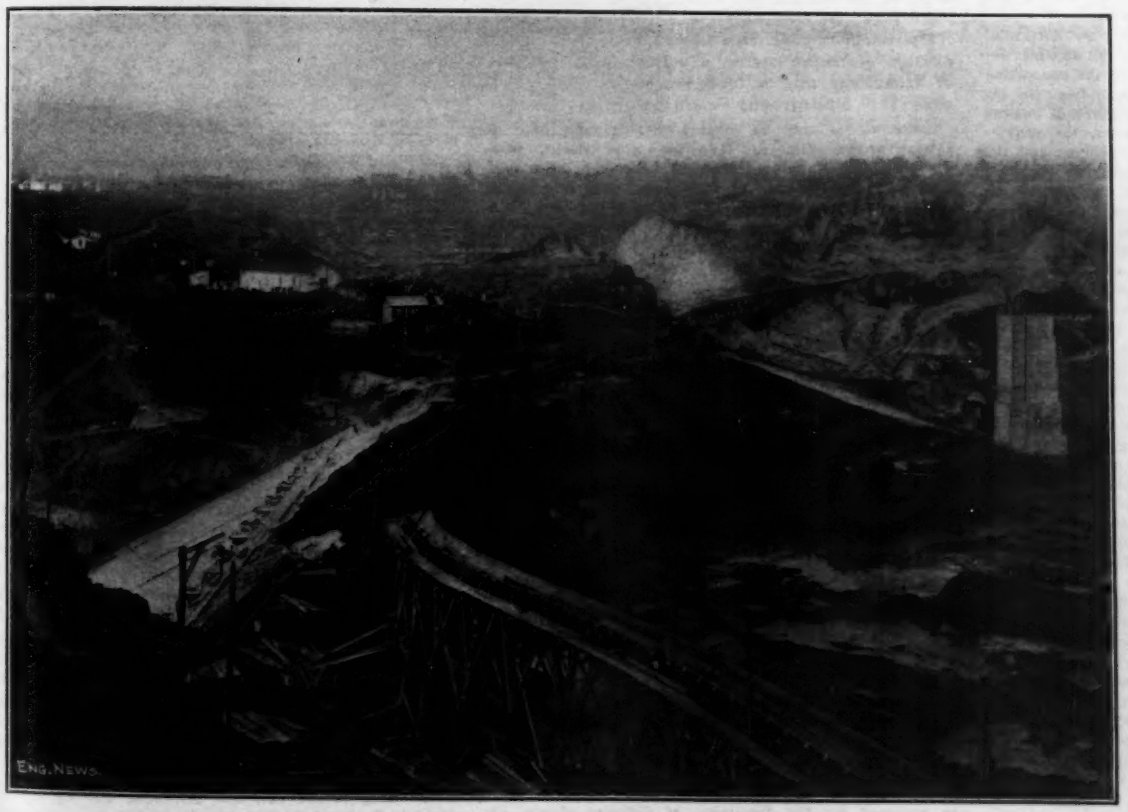


FIG. 2. PHOTOGRAPH SHOWING INTERIOR OF NECAXA DAM AFTER SLIDE.
(The view is taken from a point opposite the point of view of Figs. 3 and 4 in last week's issue.)

The Disposal of Manufacturing Wastes, Separately and with Domestic Sewage.

Among the many lectures delivered before the Engineers' Society of Pennsylvania at its convention on June 9 to 11 was one by Mr. F. A. Barbour, M. Am. Soc. C. E., of Boston, entitled "The Disposal of Manufactural Wastes, Separately and in Conjunction with Normal Domestic Sewage." After a general discussion of the complexity of the problem, and the relation of local conditions to its solution, the author dealt with the cost of treating manufacturing wastes, as follows:

> The cost of treatment is generally in proportion to the degree of purification attempted, and if the engineer does not at once appreciate the fact that money is the keynote of the problem it will soon be forcibly called to his attention by the manufacturer, to whom the expense of purification is not only a grievous raid on his pocket-book which places him at a disadvantage compared with some more favored competitor, but also, in many cases, an uncalled-for deprivation of what he believes to be a private right to discharge into the neighboring stream. That no such right exists is of course the fact. . . . A too rigid enforcement of the law forbidding any defilement of streams by manufacturing wastes would, however, result in great discouragement of industry and in the final balance of accounts would mean a loss to the people in general. Some diminution of purity is inevitable and tolerable, while other contamination is excessive and unnecessary. The problem is to draw the line. Water-supplies must be protected and anything approaching a nuisance avoided, but in many cases the discharge of matter in solution within the diluting capacity of the stream, the taint of harmless chemicals, or the stain of dyes, will work no ill compared with the commercial restraint placed on industry and the surrounding community by the requirement of an uncalled-for degree of purification of the wastes.

Many troublesome questions arise as to whether manufacturing wastes should be treated in conjunction with the general sewage of a town, or should be treated separately before being discharged into the general sewerage system; and, if separately treated, to what extent.

How Trade Wastes Threw a Sewage Disposal Plant Out of Commission.

Quite recently a successful sewage-treatment plant of some years' standing, built at the town of Hudson, Mass., was thrown completely out of commission a few weeks after the wastes from a wool-washing establishment were turned into the general sewerage system. Mr. Barbour describes this occurrence as follows:

> In Hudson, Mass., there has recently occurred an interesting example of the possible effect of a manufactural effluent on the operation of a municipal disposal plant. Some years ago, in order to prevent the pollution of the Assabet River, purification works, consisting of settling tanks and sand filters, were constructed by the town. The plant was in every way high class and the results obtained for several years entirely satisfactory. In August of last year the local board of health, which under the Massachusetts law has the power to require connections to be made with sewers, ordered a worsted mill to remove its effluent from the river and discharge into the sewerage system. The sewer commissioners permitted the connection, only requiring that adequate settling tanks be constructed by the manufacturer. The town sewage amounts to about 250,000 gals. of strong liquid; the wool waste, which is entirely from scouring processes, to about one-tenth of this amount. This waste after passing through small settling tanks at the mill—which it is claimed by the manufacturer were approved by the sewer commissioners, although this is denied—frequently contains 3,000 parts of solid matter and 1,000 parts of grease per 100,000 parts. Its temperature as it enters the sewers is 90°. Analyses made in the summer of 1908 showed a filtrate at the disposal plant low in ammonias and high in nitrates, but within six weeks of the entrance of the wool waste the nitrates disappeared and throughout the winter of 1908-9 purification was practically stopped, the filters becoming so clogged with fats that the sewage stood 3 ft. deep over the entire field, and in order to uncover the surface in the spring channels had to be cut through the embankment. Analyses of the sand show 100 parts of fats per 100,000 parts at a depth of 6 ins. below the surface, and it looks as if at least 1 ft. of the sand over the entire area will have to be removed at an expense of several thousand dollars. A suit to force the Worsted Co. to treat its sewage is now in the courts, but there are grave questions as to the rights of the manufacturer after being ordered to connect with the town system by one authority and accepted, as he claims, by those in charge of the sewerage system. Obviously, wool grease is incompatible with the successful operation of filters, and the condition described will illustrate the responsibility of authorities in charge of disposal plants to require adequate preliminary treatment.

The incident has led to the passage of a general legislative act giving the State Board of Health control in such cases.

Trade Wastes and Water-Power Complications.

A complication of quite another sort in connection with the treatment of industrial wastes may arise when it becomes necessary to give such wastes some treatment before they are discharged into a stream at a point or points above water-power plants. Such complications have arisen at Fitchburg, Mass., and are thus outlined by Mr. Barbour:

> Here on the Nashua River, in a distance of five miles, there is a fall of 200 ft. which at various points is utilized by 15 mills, which take from and return to the stream some 6,000,000 gals. of water daily. The diversion of this water into the sewer would amount to a total reduction of 200 HP. for ten hours daily in the available capacity of the river, which at $50 per HP. per year would equal an annual loss of $10,000. It is consequently proposed to subject these wastes, which are largely from paper mills, to sedimentation and rapid straining through coke filters, returning the effluent from the plant of each mill to the stream before the next privilege is reached. As the estimated expense of this independent disposal is figured at $40,000, it is obviously the most economical solution, aside from the saving thereby effected in the cost of the municipal sewers. In all cases where the water used by manufacturers is derived from a stream the diversion of the waste effluent into a sewer may result in damage to lower proprietors and the responsibility for such damage clearly remains with the manufacturer even though the effluent is taken into the town system.

On the Design of Sewage Settling Tanks.

On the permissible rate of flow through settling tanks Mr. Barbour said that a velocity of 0.01-ft. per sec. will usually

remove a sufficient percentage of any organic suspended matter and a lesser velocity will be sufficient if the solids are of greater weight. Preliminary experiments will generally amply pay for the expense involved.

Further remarks on settling tanks may be quoted as follows:

There is an opportunity for much improvement in the design of settling tanks over the common standard of an oblong, flat-bottomed receptacle of considerable depth, from which it is necessary to withdraw the liquid before the deposited sludge can be removed. As settling tanks generally form a part of any scheme of trade wastes disposal a more particular reference to their design than is suggested by the general character of this paper may not be out of place.

The movement of a suspended particle in a stationary liquid depends, primarily, upon the specific gravity of the particle relative to that of the supporting liquid. Matter heavier than the liquid will settle, those particles of greatest density being first deposited and those of less density falling at longer intervals in times proportionate to what may be called their hydraulic values. If the suspended matter is of lower specific gravity than the supporting liquid it will float and may be removed by skimming; if of about equal density it may be precipitated by the addition of some chemical which will coagulate and add weight to the suspended matter, or else, if not too fine, be removed mechanically by filtration. In settling tanks operated intermittently all particles of relative density to develop a velocity insufficient to reach the bottom during the period of rest will be removed. Continuous flow sedimentation is more commonly used and may be effected in the upward flow type or the ordinary horizontal tank. In the upward flow tank the velocity of the liquid and the downward tendency of the suspended particles are directly opposed. Those particles will be removed which have an hydraulic value greater than the upward velocity of the liquid. Except for the increased clarification resulting from aggregation of particles in settling, depth is not a factor in the efficiency and the shallowest tank in which a uniform velocity throughout the horizontal section can be developed will do as good work as if deeper.

A suspended particle in a continuous-flow horizontal tank is acted on by a vertical force, in amount depending on its density relative to that of the supporting liquid, and by a horizontal force depending on the velocity of flow through the tank. Its course in settling follows the resultant of these two factors, the heavier particles falling through a path nearly vertical and the lighter through a more horizontal course. It therefore follows, since the object is to deposit the particle on the bottom of the tank, that the shorter the vertical coordinate of the line or curve followed by the settling particle, the quicker will it be brought to rest; or in other words that with the same velocity of flow a shallow tank will remove as much suspended matter as a deeper tank in a length proportionate to that of the deeper tank as the depth of the shallow tank is to that of the deeper. As to the maximum allowable velocity, with a sufficient length of tank, the suspended matter will come to rest with any velocity which will not move the particle after it has reached the bottom, and such a tendency of bottom movement may to some extent be counteracted by baffling. Disregarding, therefore, the effect of aggregation in the settlement of the suspended matter, the most economical tank is the shallowest into which, with a flow slow enough to prevent bottom movement of the particles and long enough to provide time for the particle to reach the bottom, the liquid can be so introduced and withdrawn as to develop a uniform velocity throughout its width. There are, of course, further practical requirements in the obtaining of sufficient capacity for the accumulation of sludge and provision for the removal of the deposited solid matters. In this direction it is believed that the best results can be obtained by the adoption of a pyramidal bottom with steep longitudinal and transverse slopes, or in the case of a large tank by a series of such pyramidal sumps. Such a form of bottom will furnish capacity for the deposition of solids below the normal line of horizontal flow and at the same time obtain the steep slopes necessary for the automatic movement of the sludge to a discharge opening. By piping from such openings and where local conditions will permit a discharge from such pipes below the level of the liquid in the tank, the solids can be delivered to an adjacent drying area without pumping and withqut emptying the tank or interfering with its efficiency in sedimentation—a possibility which not only reduces the cost of maintenance but guarantees greater efficiency in actual operation. Further, in some manufactural wastes it may be desirable to separate the different matters in suspension during the process of settling, and by a series of bottom sumps this can be done and what may be called fractional sedimentation effected. Thus in the waste of tanneries and glue works the lime may be separated and the value of the more organic portion as a fertilizer increased.

In vertical circular upward flow tanks, with a conical bottom, the discharge of the accumulated solids can be made continuous provided the slope of the cone is sufficiently steep—and experience proves it should not vary from the vertical more than 30°. For the interception of stock which escapes from the cylinder and press-rolls in the felting machines of paper and hard-fiber mills, this type of tank offers great possibilities of economy. In one fiber mill where the problem was originally undertaken to prevent pollution of the neighboring stream, such a tank has been installed and is returning continuously to the felting machine more than 90% of the suspended matter and effecting a saving of several thousand dollars yearly. The effluent from the tank is sufficiently clarified to permit its return to the sprinklers of the machine, with the result that aside from the reduction in suspended matter, the amount of liquid discharged into the stream is but a small fraction of what it was previously and the actual suspended matter entering the stream is less than 1% of the amount discharged previous to the installation of this settling tank. In this case the time of passage through the tank is 2½ hours and the upward velocity of flow 0.001-ft. per sec. These conditions are, however, somewhat exceptional, as the contained iron adds weight and assists the settlement of the suspended matter. The design was predicated on a series of experiments on a small scale and the advisability of such special study of any particular waste cannot be too strongly emphasized. It should be pointed out, however, that a shorter period of sedimentation than is sometimes indicated by a small experimental tank will effect the desired result.

Trades Waste Standards and Classifications.

Where trades wastes are to be treated before discharge into a municipal sewerage system, the total output of which in turn is to be treated, Mr. Barbour suggested as a standard for the treatment of the trades wastes:

A reduction of the total solids to 30 parts per 100,000, of the fats to 20 parts per 100,000, neutralization of abnormal acidity or alkalinity, removal of any pronounced antiseptic properties, and provision for an approximately uniform discharge, will make possible the purification of the manufactural effluent in combination with the domestic sewage.

Mr. Barbour concluded his paper with a classification of trade wastes, a summary of methods of treatment and a bibliography, all of which save the bibliography we reprint, as follows:

Trade wastes may be roughly divided into those of animal origin, such as tanneries, glue works, wool works and creameries, those of vegetable origin, as from distilleries and breweries, paper, hard fiber, pulp and strawboard mills, and those of mineral origin, such as oil refineries, gas-works, iron works and chemical industries. Sedimentation will usually find a place in the treatment of the waste of the first two classes, and by such process alone, particularly in the vegetable waste in paper and hard-fiber mills, valuable stock may be recovered. Vegetable wastes, where greater clarification is possible than by sedimentation, can frequently be advantageously passed at high rates through strainers of fine material, and if such strainers are made of coke or coal the clogged surface material can be removed and burned. Owing to the stable character of the predominating cellulose, such wastes do not rapidly putrefy, and as a corollary bacterial purification cannot easily be made the method of its disposal. On the other hand, wastes of animal origin can generally be purified by nitrification in bacterial filters—not so readily as in the case of sewage because of the greater stability of much of the organic contents and the lesser bacterial activity, and usually only after a preliminary treatment necessary for the removal of a portion of the suspended solids or fats, the elimination of antiseptic properties, or the neutralization of abnormal acidity or alkalinity. In all cases bacterial purification is aided by admixture with domestic sewage.

There is such a variation in the character of manufactural effluents—even in different works of the same industry—that in the necessarily limited scope of this paper it has not appeared advisable to attempt a detailed description of particular plants. As a matter of reference, summaries of methods which have been used or proposed for the treatment of different classes of wastes are appended.

Summary of Methods of Treatment of Different Classes of Waste.

TANNERIES.—This liquid waste contains much suspended and dissolved organic matter, hair and lime. Sedimentation for a period of two hours, and filtration through fine material at a rate depending upon the strength of the liquid, will result in satisfactory purification.

An antiseptic or germicide, such as arsenic, must be removed by preliminary treatment. This can be done by passing liquid through coke or iron filings—the arsenic combining with the iron.

The sludge is of little value as a fertilizer unless dried by pressing or on sludge beds.

PAPER MILLS.—The separation of the wastes of different character is advisable.

Sedimentation of the waste liquid from the felting machines may make possible the return of valuable stock and the continuous use of the effluent from the tanks in the sprinkling system of the machines and in the beaters.

Wastes from other processes may be treated by sedimentation or chemical precipitation and filtration or by rapid straining through shallow cinder or coke beds at high rates. Little nitrification is effected but an effluent which may be safely discharged into a stream of any considerable size is easily obtainable.

CREAMERIES.—Waste liquid from the rinsing operation of creameries has been purified at a rate of 25,000 gals. through 4 ft. of medium-sized sand. Souring may prevent nitrification, and the butter fats, if present in any considerable amount, will clog the filters. Where the liquid is acid because of the souring of the milk, the addition of lime may prove beneficial.

STRAWBOARD WASTE.—This waste liquid may be satisfactorily purified by a one-hour period of sedimentation of the waste from the beaters in a vertical tank with a capacity of 1,200 gals. per ton of board produced daily, the effluent to be passed through a mechanical filter without addition of a coagulant, at a daily rate of 100,000,000 gals. per acre, the filtrate to be used again in the beaters and the sludge from the tank to be further reduced in water content by filter pressing or by drying on sludge beds.

WOOL WASTE.—The separation of the waste liquids of different character is advisable.

The scouring liquor, when mixed with sufficient domestic sewage, can be purified by means of intermittent sand filtration, but only with difficulty and at low rates because of the clogging of filtering material. Preliminary treatment of this liquor to remove solids and fats is necessary before filtration. Clarification can be effected by the addition of calcium chloride and subsequent neutralization by sulphuric acid will separate the fats. The simplest method, and the most economical, involves the primary addition of acid to a point slightly in excess of neutralization, discharge of the supernatent liquid from tanks onto cinder filters, drawing off of the sludge and drying on shallow cinder beds and hot pressing of the semi-dried sludge for the extraction of the fats.

The liquor from the washing or rinsing of the wool after scouring may be purified at a high rate in filters 4 ft. deep, of medium sand, when mixed with several parts of domestic sewage.

DISTILLERY REFUSE.—The solids, valuable as cattle food, and the water, valuable for use in the plant, may be recovered by screening the waste through filter presses, evaporating the liquid and drying solids. Evaporation will produce a slop containing not more than 75% moisture, which, when mixed with the solids from the screens and filter presses and given two dryings, will produce a cake, containing not more than 10% moisture. Experiments proved the possibility of large returns on the investment by this method. Other methods include precipitation with alumino-ferric and lime with subsequent passage through filters.

The bacterial action will be assisted by the addition of some domestic sewage to induce decomposition of the more stable manufactural wastes.

ACID IRON WASTES.—The acid in the spent pickle wastes may be profitably recovered by evaporation and crystallization.

As the first cost of the recovery plant is usually small and the recovered product valuable and easily isolated, a considerable return upon the investment is possible by this method of treating the waste.

THE RIGHTS OF THE LOWEST BIDDER in bids for public work were upheld by the Ohio Supreme Court recently in the case of an important bridge contract in Cleveland. The bids for the bridge specified the time of completion and the price, and it appeared that the low bidder, the McClintic-Marshall Construction Co., of Pittsburg, required a time several months longer than the next bidder, the King Bridge Co., of Cleveland. The Cuyahoga County Commissioners awarded the contract to the King Bridge Co., and thereupon the McClintic-Marshall Company brought suit, claiming that the Commissioners had no power to take that action. The case was important, since over 6,000 tons of steel are involved in the contract. The difference between the two bids in contest was not great, and the difference of time of completion might conceivably be held to make the second bid preferable. But the plaintiff asserted that as the advertisement and specifications had not made the time of completion a determining point, the Commissioners could not consider it in deciding. The lower courts affirmed the Commissioners' action, but the State Supreme Court reversed them and directed that the contract be awarded to the lowest bidder.

A New Single-Rope Grab Bucket.

The grab bucket shown in the accompanying illustrations is designed to perform all the operations of digging, transporting and dumping under the control of a single wire cable. This type of bucket is one of great convenience for temporary use, such as may occur in general contracting, for the reason that it is possible to use it in connection with the ordinary derrick by simply fastening one end of the bucket cable to the boom and the other to the block of the derrick. The bucket shown possesses the advantage over other single-rope buckets that it is not necessary for it to be in a vertical position in order that the closing mechanism may operate. It is so arranged that the bucket may be set at an angle of about 60°, or until it tips over, before the parts will be prevented from working.

FIG. 1. SINGLE-ROPE GRAB BUCKET WITH AUTOMATIC DUMP.
(Invented by Adolph Suck, Hyde Park, Mass.)

(The bucket shown has the tripping device for use with derricks. In the photo, although the bucket is closed the cable is slacked so that the closing mechanism is in the digging position.)

As shown in the photograph (Fig. 1), this bucket is of the clam-shell type and is hung from four steel rods attached at the outer corners of the two halves of the bucket. The bucket jaws are connected at their upper edge by two links hinged together, as clearly shown in the photograph, and one link is jointed at its point of connection to its half of the shell. Thus, the jaws are free to open within the limit prescribed by the combined length of the connecting links, except in so far as they are restrained by the closing mechanism.

The four supporting rods approach each other at their upper ends, forming a pyramidal frame, and they are united at the top by tie bars, which also form the casing for the uppermost sheave. To maintain the spacing of the rods of the frame while the bucket is open, two steel braces extend from rod to rod near their lower ends, one on each side of the frame parallel with the direction of opening. The spacing of the rods in the other direction is maintained by the rigidity of the bucket itself so that no braces are required at the ends of the frame.

The side braces of the frame contain the bearings for the ends of the shaft about which the arms and segments of the closing mechanism turn. For each jaw of the bucket, there is an arm pivoted at one end to the shaft and carrying at its other end a sheave around which the hoisting cable passes. On this same shaft is a segment to which is fastened the chain that pulls shut the jaw. The chain segment turns about the shaft independently of the sheave arm but, when the jaw is open and the sheave-end of the arm is depressed, a latch on the arm engages a notch in the chain segment. Then, when the sheave arm is raised by the hoisting cable, the segment is drawn up with it and the chain is wrapped in the groove on the segment so that the jaw is closed.

Dumping is accomplished by means of a trigger which releases the latch and allows the weight of the jaws and their contained load to open them. When the bucket is used on a derrick, the tripping device is arranged as shown in Fig. 1 to operate by simply bumping against the head of the derrick. In the case of a trolley on a horizontal boom, the tripping lever is worked by a stop placed at the desired point for dumping, as shown in Fig. 3.

Details of one of the two sets of arms and segments are shown in Fig. 2. In one piece with the chain segment, but diametrically opposite to it on the shaft is a second, somewhat smaller segment which has, near one extremity of its edge, the semi-circular notch that catches the latch pin. The latch pin is carried in a bearing on the upper edge of the sheave-arm web at a point between the sheave and the shaft, and its projecting end is of semi-circular cross-section. In the position shown in Fig. 2, the semi-circular portion of the pin engages the notch in the heel of the chain segment, holding it in the closed position. If, however, the latch pin be turned clockwise through 90° by means of the tripping mechanism, the chain segment will be released and will be pulled down by its own weight and that of the bucket jaw, while the latch pin slides on the surface of its segment.

The pin is weighted in such a way as to give it a tendency to return to the position in which it can engage the notch. Thus, when the sheave arm is lowered by slacking the cable with the bucket resting open on the coal pile, the pin slides back over the latch segment until it reaches the notch, where it is turned by the eccentric weight so as to lock the arm to the chain segment. Now, when the arm is again raised by the cable, the segment is drawn back to the position shown in Fig. 2 and the jaws are closed.

The bucket is shown in the closed position in Fig. 3. In this position it may be hoisted or lowered as desired by simply slacking or pulling in the cable. One end of the single cable required is fastened to an eye-bolt on the trolley or derrick boom. From the eye-bolt, it passes around one of the sheaves carried on the closing arms, over the central sheave, which is merely an idler, at the top of the pyramidal frame, around under the second closing sheave, back up to the pulley on the trolley and thence to the winding drum. The closing sheaves on the bucket are enclosed in special cases, visible in Fig. 1, which protect the cable and sheaves from contact with the material to be loaded and prevent the fouling of the cable when it is slacked to lower the arms.

When the bucket is carried along by the trolley until the tripping lever strikes the stop, the lever is pushed to a vertical position and the latch is released so that the jaws drop open as shown in Fig. 4, dumping the load. In this position, the bucket is returned to the pile from which material is being transferred and is lowered, or dropped, by slacking the cable, so that the jaws dig into the pile. Further slacking of the cable while the bucket rests on the pile lets the sheave ends of the arms drop down, as shown in Fig. 5, so that their latches engage the notches on the heels of the chain segments. The cable is then pulled in, raising the arms and with them the chain segments. This closes the jaws around their load and brings the bucket again to the position shown in Fig. 3.

The tripping device used in connection with derricks is shown in Fig. 1. A spring buffer at the apex of the bucket frame has attached to it a short link which in turn is pinned to one arm of a bell-crank pivoted to an extension of the case for the upper sheave. The second arm of the bell-crank projects downward against the trigger of the latch pin. When the bucket is pulled up so that the buffer strikes a knocking piece on the head of the boom, the attached link depresses its arm of the bell-crank and the other arm pushes open the latch.

In Fig. 1 the latch trigger is not in contact with the tripping device for the reason that, although the jaws are closed, the bucket rests on the ground and the cable is entirely slacked. Thus the jaws are in the position shown in Fig. 3, while the sheave arms and other members of the closing mechanism are dropped as in Fig. 5. The position shown in Fig. 1 would never occur while the bucket was being used.

This bucket is the invention of Mr. Adolph Suck, of Hyde Park, Mass., who states that it has been successfully used in both anthracite and bituminous coal.

Testing Oil for Steam Turbines.*

By ROBERT JOB.†

The lubrication of heavy rapidly-moving machinery is of extreme importance owing to the necessity of continuous running. In many places the heating of a bearing may result in cutting off power, with the attendant inconvenience and loss. At times, as for instance in some types of steam-turbines, the bearings are very closely adjusted and, if the oil is not entirely clear and free from waxy substances, clogging and heating very quickly results. In many places also oil is used in a "system" or, in other words, in a large tank which frequently holds thousands of gallons. This oil is pumped above the bearings and allowed to flood them, and thus is used over and over again. In course of time it has been found that with some oils a settling of a waxy sludge results, causing clogging of the filters and other difficulties.

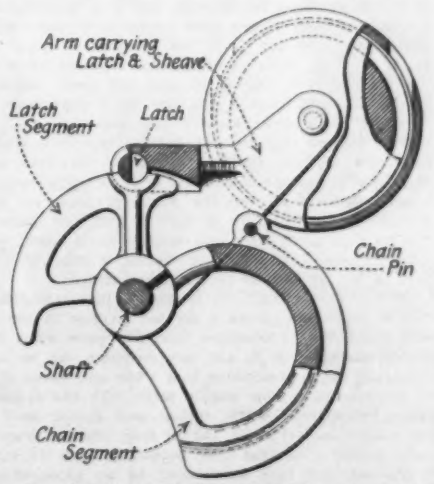


Fig. 2. Detail of Closing Mechanism for Single-Rope Grab Bucket.

In view of these conditions it was thought desirable

*A paper read before the American Society for Testing Materials, at Atlantic City, June 28-July 3, 1909.

†Of Booth, Garrett & Blair, 406 Locust St., Philadelphia, Pa.

to investigate carefully to determine whether some simple test could not be developed which could be used in connection with routine examinations of shipments in order to bar out this undesirable quality.

As an aid in studying the subject a number of red engine and turbine oils some of which had given good service and others bad service were thoroughly tested and it was found that the usual constants gave no indication of the service obtained in this particular. Clearness and freedom from all turbidity were of importance, but mere color, or lack of color, seemed to have little influence and good service results were obtained with oils which were of a red color, as well as with those which were filtered to an amber color.

HEATING TEST.—After experimenting with a number of tests, it was found that on heating the oils to a temperature of 450° F. all of the oils which had given bad service showed a very marked darkening of color, while those which had proved satisfactory showed very little change. Our investigations indicated that filtering to a light color, as for instance that of a "sun-bleached" oil, is unnecessary, since good results have been obtained even under exacting conditions with oil of fairly deep color. But the point of importance appeared to be that the oil had been filtered or else had been chemically treated in such manner that the waxy substances, the so-called "amorphous waxes," had been completely removed, and on applying the heating test only a slight darkening of color resulted. It seems therefore to be of decided advantage in addition to other requirements to specify that an oil for the above purposes on being heated to a temperature of 450° F. and held there for five minutes shall show not more than a slight darkening of color. The test, of course, is that commonly used in test of 300° oil for burning purposes.

SEPARATING TEST.—It is known that the elimination of the waxes causes a decided increase in the ease with which the oil separates from hot water when thoroughly shaken with it, and this condition can be taken advantage of by prescribing that when one ounce of the oil is placed in a 4-oz. sample bottle with two ounces of boiling water, the bottle corked and shaken hard for one minute and let stand, the oil must separate from the water within a specified time, depending upon the nature of the oil, and that there must be no appearance of waxy substances at the line of demarcation between the oil and the water.

These tests are simple and practical, and seem to give an excellent index, in conjunction with the usual tests, of the service value of oils used under these conditions of service.

WIRELESS TELEGRAPH STATIONS IN CHINA, according to the "Far Eastern Review," are to be erected in the interior for the purpose of establishing communication between Peking and the northwestern portion of the empire across the Gobi Desert. Preliminary investigations of wireless installations are now being made by the Board of Posts and Communications.

Disintegration of Fresh Cement Floor Surfaces by the Action of Smoke Gases at Low Temperatures.*

By ALFRED H. WHITE.†

A source of trouble which so far as the author is aware has never before been observed in practice, was called to his attention by the behavior of the newly-laid surfaces in a large 8-story reinforced-concrete warehouse. The floor surfaces were laid during the months of December and January, the window-openings being closed and fire-pots kept going so that the temperature never actually dropped to freezing. At the time of the writer's visit in February the floors looked in good condition, but a few scrapes of the shoe produced evident abrasion and it was easy to rub a hole an eighth of an inch deep.

The following data were furnished as to the manner of laying floors. The concrete floors had been covered with about an inch coat of a mixture of one part cement to two of crushed granite. At first it had been mixed decidedly wet and applied to wetted floors. As poor results became apparent variations both in mixture and method of application had been tried. At least two different cements had been used, sand had been substituted in one spot for granite, and a drier mixture had been applied on a dry floor. In all cases, however, the set had been so slow that it had been eight to ten hours before the surface could be trowelled.

The cement had passed the architect's tests and the architect's samples on re-examination showed themselves up to the required standard. The crushed granite possessed a fair gradation in size of particles. Microscopic examination did not show an undue percentage of mica in the granite nor in the sweepings brushed off the floor, thus doing away with the suspicion that the mica floating to the surface could have caused the trouble.

This failure to find the trouble in the raw materials directed attention more particularly to the conditions surrounding the hardening process and especially to the effect of the carbon dioxide of the gases from the open braziers on the slowly-setting cement. Analytical methods could avail but little here, so direct experiment was resorted to. It was desired to test the effect of setting at temperatures very little above the freezing point both in ordinary air and in an atmosphere rich in carbon dioxide, and to further try the effect of an impervious base corresponding to a thoroughly-wetted concrete foundation, as compared with the effect of a dry porous base which would absorb the excess of water from the concrete and thus rapidly and mechanically cause enough rigidity to prevent differential settling of the very fine particles of cement.

The experimental method was as follows: To obtain a uniform and porous base, small dishes of unglazed clay, the scorifiers used by assayers, were employed. These were thoroughly soaked in water before use, but the evaporation of water from the outside of the dish still caused a relatively rapid absorption of water from the concrete within the dish. To obtain the non-porous base other similar dishes were soaked in melted paraffine and then allowed to drain and cool. Two separate series of tests were made with different cements and the crushed granite mentioned before from which everything had been sifted out which did not pass a 20-mesh sieve. One part of cement was used to two of granite and enough water was added in the mixing to make the mixture jelly-like. The molds were at once placed in the cold room or other place where they were to be observed.

Since there is no quantitative way of measuring the friability of a surface it is hardly worth while to repeat the details of the tests. They all agreed in showing that the pats which had set in ordinary pure air but at a temperature of 36-38° F., and which had taken 7 to 8 hrs. for their initial set gave slightly dusty surfaces, but that the pats which had hardened under conditions exactly the same except that the air above them had contained about 6% carbon dioxide had surfaces which could be rubbed to dust very readily with the fingers. The harmful effect of the carbon dioxide was unmistakable.

The tests on the effect of absorbent or non-absorbent bases did not yield nearly such conclusive results, and it was not always possible to detect much difference between them. A chemical analysis of sweepings from the floor of the warehouse mentioned above showed in one case only 40% and another 46% of material insoluble in dilute acid and alkali, which may fairly be held to indicate the proportion of granite in this disintegrated surface. Inasmuch as the material as laid was supposed to be 66% granite, it indicates, even after making allowance for the absorption of the carbon dioxide, that there had been a decided concentration of cement on the surface instead of an impoverishment which would have weakened it. These tests do not indicate that the effect of the slow setting, as apart from that of the carbon dioxide, had been of great importance.

It is only within the last few years that modern building methods have given rise to conditions which would cause trouble from this source, and it has, so far as the author is aware, never been brought to the attention of engineers. He therefore felt justified in presenting this first case of injury from this cause which has come to his knowledge, together with an experimental verification of the cause of the trouble. It will be of interest to add that, although various remedial paints were tried on these floors, the only effective treatment was to grind them down with stone rubbers and carborundum to a hard surface.

CONCLUSIONS.—Smoke gases, on account of their carbon dioxide, exert a very harmful effect on hydraulic cement setting at a temperature below 42° F. This action is a superficial one and would probably not appreciably weaken structural concrete, but merely cause dusting of the surface. The effect is most noticeable on floors. It is probably never advisable to lay the top-coat of floors in rooms which are being heated by open fires, but if this is unavoidable, the temperature should be kept safely above 45° F. A higher temperature will act advantageously in preventing an excessively slow initial set of the cement.

*Abstract of a paper presented before the American Society for Testing Materials, at Atlantic City, N. J., June 28-July 3, 1909.

†Junior Professor of Chemical Engineering at the University of Michigan, Ann Arbor, Mich.

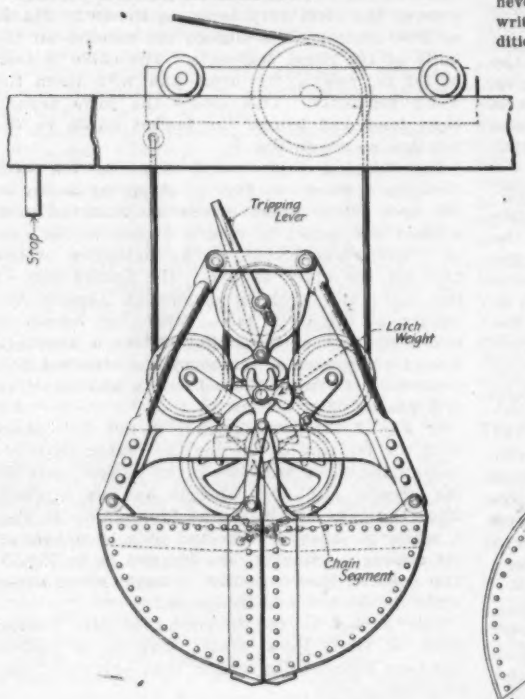


Fig. 3. Closed or Loaded Position.

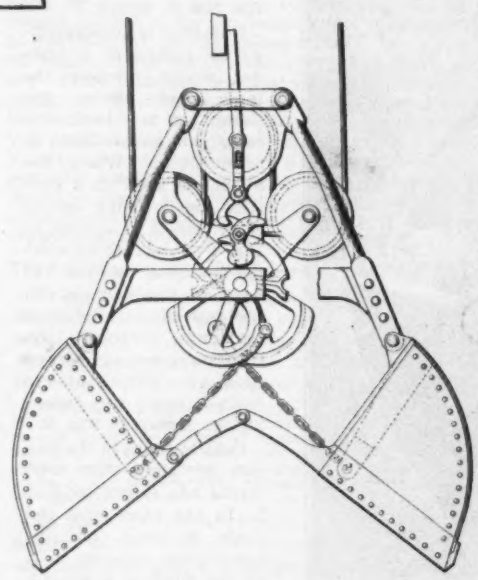


Fig. 4. Dumping Position: Jaws Dropped.

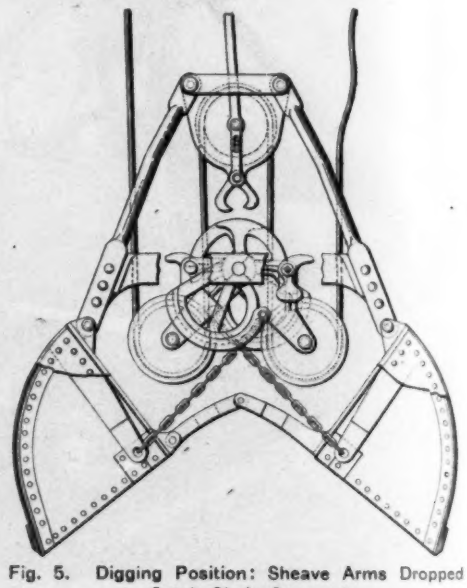


Fig. 5. Digging Position: Sheave Arms Dropped to Catch Chain Segments.

FIGS. 3, 4 AND 5. DIAGRAMMATIC VIEWS OF SINGLE-ROPE GRAB BUCKET, SHOWING THE THREE OPERATING POSITIONS.
(These views show the tripping device for use with trolleys.)

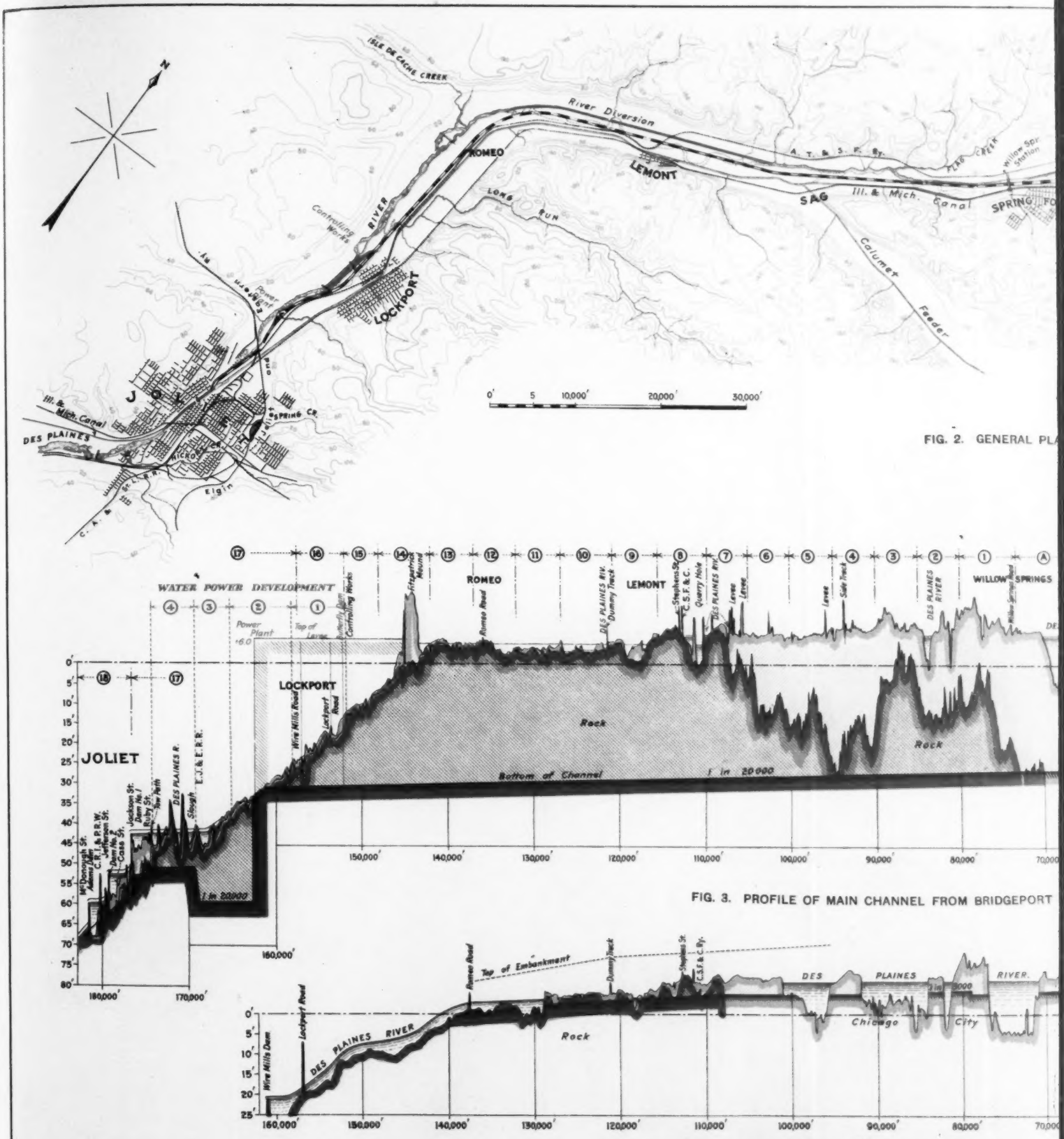


FIG. 2. GENERAL PL

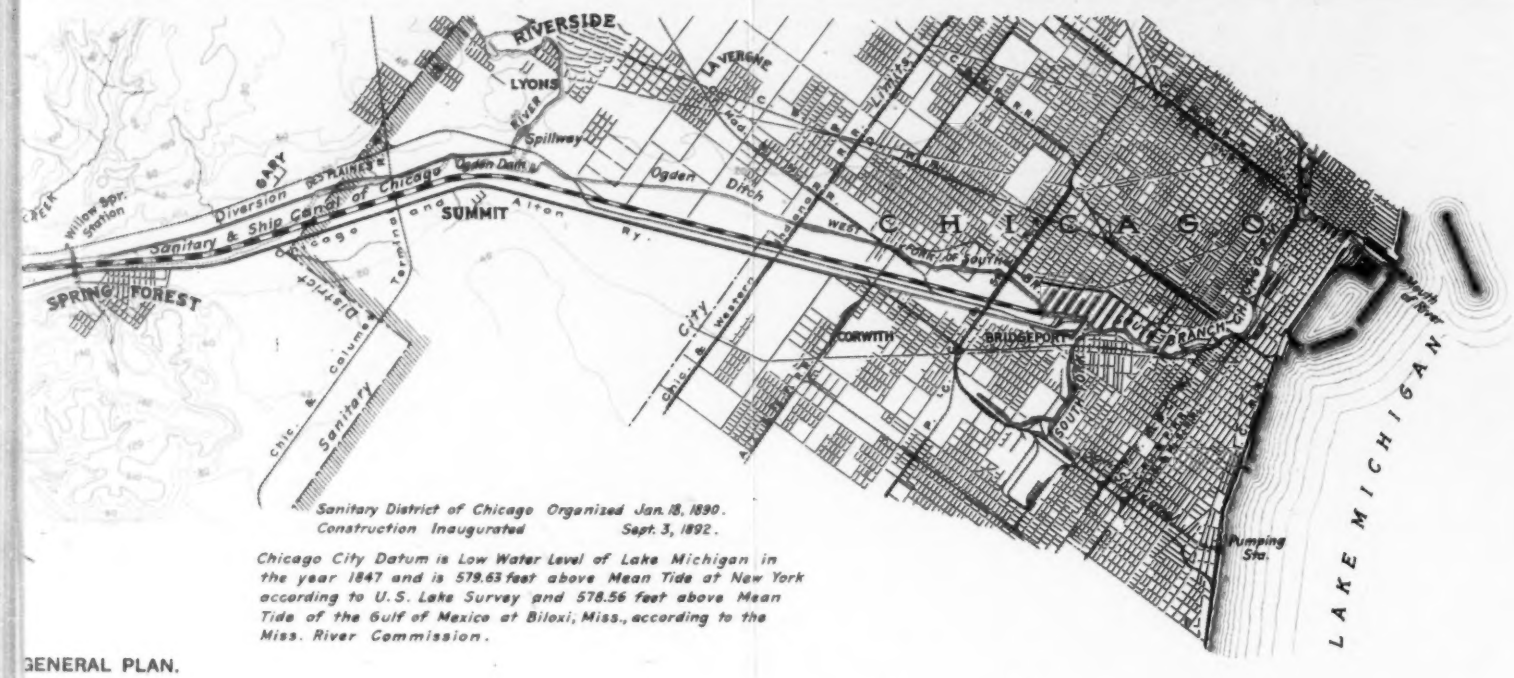
FIG. 3. PROFILE OF MAIN CHANNEL FROM BRIDGEPORT

FIG. 4. PROFILE OF DIVERSION OF THE DESPLAINES RIVER.

THE CHICAGO MAIN DRAINAGE CHANNEL FOR T

SEWAGE INTO THE DESPLA

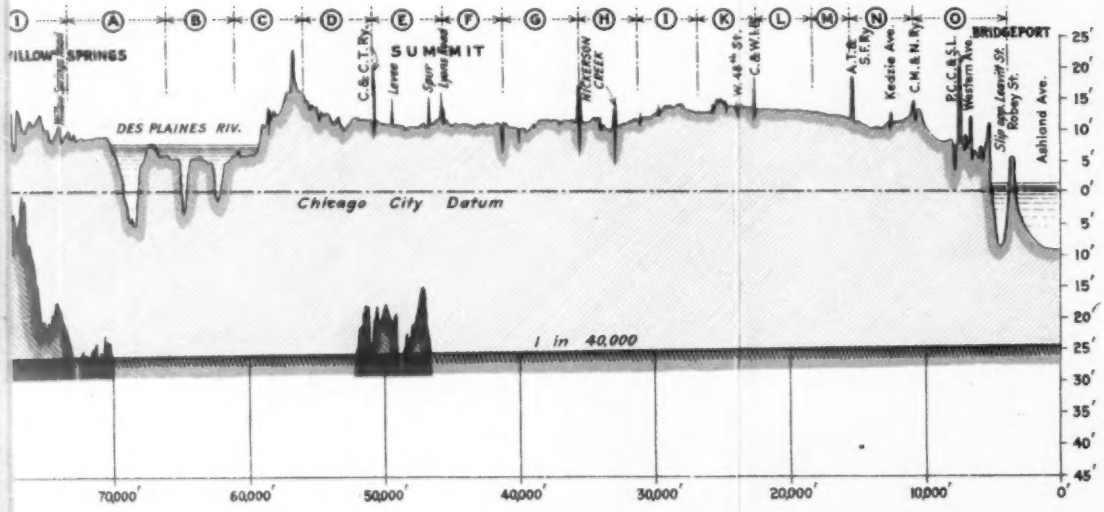
Isham Randolph. M. Am. Soc. C. E., Consulting Engineer



Sanitary District of Chicago Organized Jan. 18, 1890.
Construction Inaugurated Sept. 3, 1892.

Chicago City Datum is Low Water Level of Lake Michigan in the year 1847 and is 579.63 feet above Mean Tide at New York according to U.S. Lake Survey and 578.56 feet above Mean Tide of the Gulf of Mexico at Biloxi, Miss., according to the Miss. River Commission.

GENERAL PLAN.



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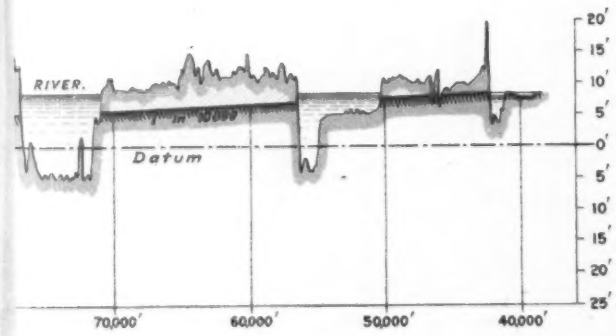

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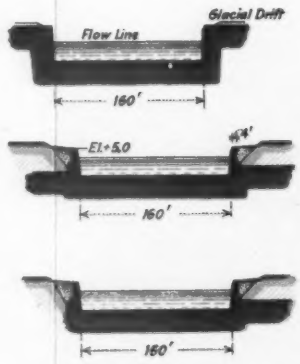

FIG. 5. CROSS-SECTIONS OF CONTRACT SECTIONS 1 TO 15.

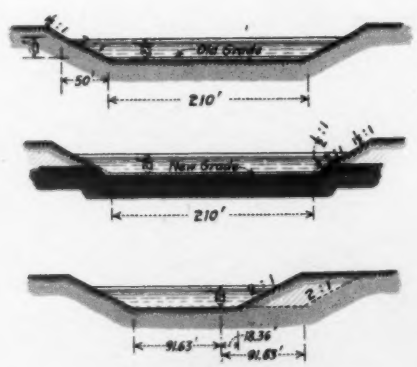

FIG. 6. CROSS-SECTIONS OF CONTRACT SECTIONS A TO O.

L FOR THE DILUTION AND DISCHARGE OF

DESPLAINES RIVER.

George M. Wisner, M. Am. Soc. C. E., Chief Engineer.

LITHO. BY CHAS. HART, 38 VESEY ST. N.Y.

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For nearly a quarter of a century, we have been recording in the pages of Engineering News the progress on the Chicago Drainage Canal and its auxiliary works, constructed to dispose of the sewage produced in the great center of population at the head of Lake Michigan. But while this great work—among the greatest ever carried out by engineers—has been in progress, a new generation of engineers has been growing up. Among the men active in the profession to-day there are a very large proportion who were reading literature much more elementary than Engineering News in the years when the Drainage Canal was building.

It has seemed worth while, therefore, to present a connected story of the Drainage Canal from its inception; and this we do in this issue, with Mr. Isham Randolph as the story-teller. Mr. Randolph was for 14 years, during the most important part of the period of construction Chief Engineer of the canal and he has since then been its Consulting Engineer.

The method of sewage disposal adopted at Chicago is absolutely unique and unprecedented. Nature made it possible for the city to create a new outlet from the Great Lakes into the Mississippi instead of the St. Lawrence. By turning its sewage into this outlet instead of pouring it into the lake from which its water supply is drawn, Chicago solved at once the problem of sewage disposal and of water supply.

Looking back now, with the knowledge of the present day, it is difficult to see what Chicago could have done to solve its problem of waste disposal had not the drainage canal plan been adopted. Surely, it could not have gone on indefinitely pouring all its outflow of filth into the lake on whose shores it lies. The water supply drawn from the lake might possibly have been purified by filtration; but eventually with the increase of population and of manufacturing and sewage discharge, the whole mass of lake water next the city must have become one vast reeking cesspool. The case is far different, it must be remembered, from that of a city located on salt water, where the tidal flow constantly carries away and dilutes and distributes the sewage discharge.

Even as it is, with the sewage of Chicago and a large part of the adjacent territory removed from Lake Michigan, the pollution of the south end of the lake is serious enough to constitute a problem which must be faced in the near future, as we showed in our last issue.

In considering possibilities in the way of sewage disposal, it must be remembered that the size of the city, the amount of dilution of its sewage and the character of land available in the vicinity are important elements in the problem. There is a vast difference between handling the sewage from a city of a hundred thousand population and a city of a million. Berlin is a notable example of a great inland city disposing of its sewage on land; but if Berlin's population used (and wasted) four or five times as much water per capita as it now does and the city were surrounded with clay deposits instead of barren sandy plains, then the problem of sewage disposal would be vastly more difficult.

Considering, therefore, all the conditions at Chicago, it appears that the construction of the drainage canal was not only the wisest but about the only possible satisfactory solution of the sewage disposal problem. The other large cities on the Great Lakes, Cleveland and Milwaukee, would esteem themselves fortunate if they could as easily pour their sewage out of their back doors and leave their source of water supply unpolluted.

As for the evil results which were prophesied from the drainage canal, they have nowhere materialized. Granted that the Illinois River is not of ideal purity, it is yet far better than it was before the drainage canal was opened, when Chicago was pumping a stream of concentrated filth into it through the old Illinois and Mississippi canal. The lowering of the levels of the Great Lakes and their connecting channels due to the new outlet from Lake Michigan, has been marked by the seasonal variations in level and by the works of channel improvement carried on by the Government. Whatever lowering of lake levels may have resulted from the Drainage Canal outflow, will almost certainly be restored by the channel-regulating works at the outlet of Lake Erie, which are likely soon to be established.

A remarkable instance of the use of an ounce of prevention instead of waiting until tons of cure might have been required occurred recently in connection with a large dairy which supplies milk to a number of important New Jersey suburbs of New York City. The instance is all the more remarkable because it illustrates the spirit of progress, publicity and cooperation with health authorities now being shown by some of the corporations which are serving the public, and also because it affords an example of the value of the trained technical man in serious emergencies, public and private alike.

The case we have in mind was the sudden occurrence of scarlet fever on the large dairy premises named. How the emergency was met and the public health protected without shutting off the milk supply of hundreds of consumers in many towns and cities is described elsewhere in this issue by the technically-trained man who was employed to direct the precautionary measures decided on.

Some readers may be surprised to find that the local boards of health apparently took so little part in the incident described. It should be remembered, however, that the author of our article is primarily concerned with the work of the Essex County Medical Milk Commission.

Moreover, so prompt and thorough was the supervision and work of the commission and the dairy company that there was little need for the various local boards of health to do more than satisfy themselves that everything was being done that needed to be done to protect the public. This is certainly a near approach to the ideal. The all-too-common course of events is for an epidemic to break out before local health boards suspect that danger of one exists. Instead of notifying milk or water consumers that milk or water is badly infected and should be boiled, how much better to give wide notice that the possibility of infection has been recognized and the consumer relieved of all need of fear or of action, as was done in the case of the milk supply under consideration!

The general adoption of such practices would leave health boards idle, empty hospitals and cause undertakers to commit suicide.

The Chicago "Post" sounds a warning to engineers of the present day by printing a prophecy made by an engineer in 1837 concerning the future of the Illinois & Michigan Canal, as follows:

> The Illinois and Michigan Canal, as now projected and under construction, may truly be considered one of the greatest and most important in its consequences of any work of any age or nation. * * * I think it justly merits to be executed upon the best and most permanent plan, and will justify by its revenue any outlay which may be put upon it in reason.—Benjamin Wright, Engineer, 1837.

The "Post" comments on this prophecy thus:

> What Mr. Wright predicted would be "one of the greatest works of * * * any age or nation" is now known to a disrespectful generation as the "tadpole ditch." It is an open green sewer which rambles along under an annual deficit.
>
> This bit of history is useful as a reminder of the limitations of the engineering profession. As prophets they are not infallible, whichever side of the proposition they may take. The deep waterway problems now confronting the people of Illinois are financial and commercial, not those of technical engineering. They are problems which the leaders of our industrial life cannot shirk. The more sound and statistical our study of the probable future waterway traffic, the safer will be our investments therein.

Thus is an ill-judged prediction made by an engineer over seventy years ago brought up as testimony against the reliability of the profession at the present day! Is it not an illustration of how the errors of one engineer hurt the profession as a whole, even as the achievements of the individual add to the profession's prestige and reputation? Unfortunately a single error will have more influence than a hundred cases of work well and honestly performed.

Of course, engineers are not infallible; and for that very reason, engineers of reputation and standing and a true appreciation of their responsibility to the profession and the public are very careful how they place themselves on record with such prophecies as the "Post" credits to some forgotten engineer of 1837.

Unfortunately, some engineers fail to realize that their careless statements may some day reflect not only on themselves but on the reputation of the profession as a whole. Unfortunately, too, the public credits the engineering profession with a great deal of stuff which gets into print, emanating from men whom the profession would be glad to disown. But as any man can call himself an engineer and pose before the public as such, the profession has to take the blame for many things for which it is in no way responsible. For aught we know, the above quotation credited to Benjamin Wright may fall under this category.

Among the newspaper articles relating to engineering matters, which an industrious clipping bureau forwarded to us recently, were two headed respectively: "Socialism in the Concrete" and "The Steam Roller in the Senate."

Unnecessary Widths of Country Roads and City Streets.

There has been a strong tendency in many quarters of late to reduce the width of the portion of streets lying between the curbs and devote the space thus gained to grass and trees. Little or nothing has been said in this country about the unnecessary width of country roads between fence lines. Mr. Robert J. Thompson, U. S. Consul at Hannover, Germany, has recently called attention to the different practice regarding the width of roads that prevails in Germany. According to the New York "Tribune," Mr. Thompson says:

> German roads are perhaps subjected to a hundred times more traffic than similar roads in the United States.

These roads range from 20 to 30 ft. in width, while in our Middle or Western States, where the traffic is comparatively light, we take land of an average value of $100 an acre and cut it up with roadways 66 ft. in width, practically two-thirds of the same being given over to weeds, which furnish an inexhaustible supply of seeds for the adjoining farm lands. The farmer in Germany who has conquered the weeds on his ground need have no thought of their being started again from uncultivated or uncared for land along the roadways. There are no weeds, no mud or chuck holes, no sand stretches in the roads. Looking into the valleys from one of the thousands of lookout towers, which have been placed on the summit of nearly every high elevation of land or mountain in Germany, the roads lie before one's view like bright white ribbons, running past squares of green or brown fields, along the verges of cultivated woods, and binding village to village—a solution of the first and most important problem of human economy and evolution, that of transportation.

Mr. Thompson estimates that in 13 of the great agricultural states of the Middle West there is a total of 700,000 miles of country roads. By reducing the width of these highways from 66 to 36 ft., there would be given back to the farmers for cultivation 2,500,000 acres of generally tillable land, which at an average valuation of $100 an acre would mean the restoration to the producing values of the states named of $250,000,000. This sum has an annual interest value of $12,500,000, an amount which might be recovered, and if applied to the proper scientific construction of roads in the United States would in a few years give us the most extensive and finest country road system in the world.

The subject is certainly worthy of careful consideration on the part of road authorities, agriculturists and the public generally.

Presumably one reason why the country highways of America have been made so wide was that there might be plenty of material available along the roadside for mending the roads in the good old-fashioned way of throwing material from either side into the center of the road, regardless of the suitability of the material for road purposes. Now that better ideas in road construction are gaining practical recognition this argument for wide highway reservations, only one-fourth or less of which is used, loses much of its force. Of course there are hundreds of thousands of miles of little-used country roads which must continue to be repaired with whatever adjacent material can be most cheaply thrown into the roadway. The most that can be hoped for on these highways is that the road scraper and road drag will be substituted for the plow and shovel or drag scraper. By such means the best possible use will be made of such material as is closest at hand, and, what is directly to the point of the subject under discussion, extra-wide highway reservations hundreds of thousands of miles in length will not be required in order to make available a chance deposit of gravel here and there. Where large borrow pits are needed they may be acquired by purchase, condemnation or lease, either alongside or off the highway. Rarely, indeed, do the demands for road material call for a continuous four-rod highway strip, even under the old system of road construction and repair.

In those sections of the country where the unused portion of the highways rapidly grows up to weeds and brush the laws generally require that the brush and weeds along the highways shall be cut annually. This entails considerable trouble and expense to the farmer, and ordinarily brings him no compensating return. If his fence line were moved nearer the roadway, the ordinary operations of tillage would keep down the weeds and brush where the land is under cultivation, and where it is not the land would be available for pasture or forest. Obstacles to the useful restoration of these highway strips in certain portions of the country are the old stone walls that were built many years ago, when labor was much cheaper than at present. These walls would render inaccessible the strips of land given back to cultivation; but where the land is in pasture or in forest, the walls would present no difficulties. Most new fencing is now of wire and can readily be placed wherever desired. In fact, it is almost necessary, for economical construction, to put it one side or the other of the old stone walls, where these are in existence.

In some parts of the country, pasture lands excepted, fencing is neither so necessary or common as it once was. In the absence of fences, there seems to be no good reason why land worth cultivation should not be cropped to the ditch line, thus both utilizing all the land not in use for road purposes, while at the same time keeping down noxious weeds and objectionable brush.

A lesson in the utilization of unused lands is afforded by the reported action of two of the great trunk railway lines of the west. It is stated that the Union Pacific has begun to plant catalpa trees on the outer sides of its 200-ft. right-of-way in Nebraska. The Chicago & Northwestern, it is reported, is utilizing some of its right-of-way by leasing it to abutting farmers for alfalfa raising. Both plans, or modifications of them, are worthy of consideration by other railway companies, as well as by highway authorities, throughout the country.

The arguments for narrowing the width of city streets to the actual needs of vehicular traffic are even more forcible, relative lengths of roadway considered, than those for narrowing country highways. Very few cities and towns in the United States have been able to improve all the streets with any approach to efficient pavement or macadam, and fewer still keep such of their streets as are improved in anything like decent condition. With the constantly increasing demand for better classes of pavement and for a form of macadam construction that will be dustless, it will become more and more difficult to secure sufficient funds to construct and maintain good street surfaces from curb to curb of the thousands of miles of unnecessarily wide streets that now extend through our cities.

Presumably, in many if not most states it will be necessary to secure new legislation before roads and streets can be narrowed in accordance with the foregoing suggestions. But there ought not to be any difficulty in getting this legislation if the arguments for it are forcibly and wisely stated. In the case of city streets it will be necessary to put their control in the hands of some intelligent board or city department, and give that department power to regulate and alter the width of streets and to say how their surfaces shall be improved, instead of leaving both width and surfacing material subject to the caprices of individual property owners.

The land reclaimed from the muddy or dusty wastes of unnecessarily wide city and town roadways generally remains vested in the public, as in most cases is proper. Open spaces not subject to encroachments by buildings are thus preserved and at the same time their value for breathing spaces, general comfort and esthetic purposes is or may be increased by turning the regained ground into grass and planting it with trees and shrubs.

As already intimated, the land reclaimed from the weeds and brush of country roadways would generally revert to or remain vested in the abutting owners, and be added to the fields, pastures or forests. In case legislative or legal difficulties, or conservatism, stood in the way of such reversion of actual title, it still might be feasible to give abutting property owners the right to plant forest, shade, or fruit trees between the ditch and property lines. The right to plant shade and fruit trees already exists in most if not all states, but our impression is that forest planting on highway reservations, no matter how wide the reservation may be, would be against the spirit if not the letter of the highway laws of the country. We think some concessions might well be made, at least on each outer rod of four-rod highways in sparsely settled districts.

As an alternative to private planting, there are strong arguments in favor of tree planting at public expense. The strongest of these arguments are the slowness of returns from forest planting, the practical lack of money return from shade trees, and the greater efficiency to be expected from substituting unified for diversified control of planting and maintenance.

Finally, we may note that narrowing and parking unnecessarily wide city and town streets has previously been given considerable attention by city engineers and town-planning experts, and has been discussed from time to time in these columns. The benefits from such a practice are quite generally recognized in engineering and esthetic circles, and are slowly dawning upon the minds of the general public.

In contrast, little thought, even, has been given to the millions of miles of our brush-and-weed-covered and unnecessarily wide country roadsides. Although a large percentage of the land along these country highways is still of little value, there are thousands upon thousands of miles of double highway strips taken out of valuable farm lands, which, together with vast additional mileages, are not only largely useless to-day but are actually breeding places for noxious weeds. Other areas, immense in their total, are covered with nothing but dense brush, and are doomed to remain brush land instead of timber land through highway laws that seem to compel clean cutting from fence line to fence line. The time is rapidly coming, if it has not already arrived, when much of this roadside area ought to be devoted to useful purposes. Such strips as cannot, for any reason, be devoted to crops or pasture, might be planted with forest, shade or fruit trees, including nut bearers, thus contributing to the great natural conservation movement by a happy junction of the useful and the beautiful.

LETTERS TO THE EDITOR.

The Gatun Experiments on Seepage Through Earth Dams and Their Interpretation.

Sir: I read with great interest in Engineering News of Dec. 24, 1908, the description of the experimental Hydraulic-Dredge-Fill dams at Gatun, made by Mr. C. M. Saville for the Isthmian Canal Commission. The work was evidently carefully and thoroughly done and the report upon it is a valuable addition to engineering knowledge. There are, however, a few interesting facts relating to the plane of saturation which seemed to have been overlooked and others which might have been interpreted differently.

A line through the elevations at which the water stands in the gage tubes is called in this article either the hydraulic grade line, the saturation line or the slope of saturation. Experiments have shown that these lines are not always identical, especially near the upstream end, the saturation line being above the hydraulic grade line, as determined from pipes exposed only to the hydraulic head near the bottom of the tank. The distance between these lines is equal to the difference between the head used in penetrating the bank to the gage pipe, and that in reaching a corresponding point on the surface of the slope.

The slope of saturation which will obtain in a tight-bottomed tank under conditions similar to those of the Gatun experiments, no matter what the material or the shape of the embankment or tank, will obviously be a curve joining a point near the surface of the water with a point at the downstream end of the embankment at some appreciable distance above the bottom of the tank. The slope cannot touch the bottom of the tank if there is any flow at all, for as $q = sv$ and "a" varies directly with the distance from the floor to the saturation plane, any decrease in "s," making it very small, will make v approach infinity.' The velocity of water percolating through a fine sand or similar material is very slow, therefore the downstream end of the plane of saturation must be at such a height above the bottom of the tank as will permit a reasonable velocity.

These experiments have not shown that under conditions obtaining in an embankment confined in a tank, there would be a material change in the *slope* for materials having different resistances to flow. The *quantity* of percolation would vary according to the laws governing it; but the slope, for a constant length and head, might remain practically unchanged provided each material was homogeneous throughout the embankment. In so far as it affects the slope of saturation, the assumption that the bank need not include all of the dam is erroneous, as the factor most influencing the slope of saturation, under the conditions of these experiments, is the length of the embankment. The extension of the slope, as found in the short tank, to an intersection with the bottom of the base of the dam is, for the reasons stated above, entirely unwarranted.

Some of the factors most influencing the slopes of the planes of saturation in earth dams are as follows:

(1) The permeability of the foundation upon which they are built or the natural and artificial under-drainage under the downstream slope.

(2) The relative permeability of the materials in the upstream and downstream portions of the embankment.

(3) The width of the dam is a factor in so far as the conditions approach those of the experimental dam at Gatun, that of having a water-tight foundation.

Relative permeability of materials influences the line

of saturation in the following manner: a layer of relatively impervious material near the source limits the quantity of percolation to such a small quantity that when it reaches a more permeable medium it will occupy less space and flow away with much less loss of head, causing a marked steepening in the saturation slope where the permeability changes. The Gatun experiments show a good example of such a steepening of the hydraulic grade line, it being a result of a *change* in the permeability rather than "the effect of permeability on the hydraulic grade line," as suggested by Mr. Saville.

The conclusion of the Board of Experts which tested the saturation planes in dams of the Croton watershed and also of Mr. Saville that the slopes there found were due to the nature of the materials of which the dams were built cannot be sustained by the facts.

The various slopes of the saturation lines in the Croton dams as well as those in the Wachusett dikes are controlled principally, if not entirely, by one or all of the three factors above stated, and not to any great extent by the nature of the materials of which these dams are built.

The Carmel, Carmel Auxiliary, Bog Brook and Titicus dams were built of similar materials and under similar specifications and supervision. The flat saturation slope on the downstream side of Titicus dam rises but little above the original surface of the ground at any point. Its position may be accounted for by the porous character of the earth under the downstream portion, which acts as an underdrain. The Carmel dams are similar except that springs were found on the downstream side of the Auxiliary dam site, and the artificial drainage which was introduced to carry off flow from these springs also carries off the seepage through the dam. Consequently, there is more leakage, but less saturation in the Carmel Auxiliary dam than in any of the others. At Bog Brook, Carmel, Amawalk, and Middle Branch the slope of the plane of saturation is determined mostly by the cross-section of the dam. Amawalk and Middle Branch dams are of similar type and the slight difference in the slope of the saturation line is due to the partial underdrainage of the Amawalk dam by strata of permeable earth.

In the Wachusett dikes, the core of rolled earth offers so much resistance that only a small quantity of water reaches the more pervious portions of the dike and the large area of pervious materials underlying the dike, where its only effect is to raise slightly the original ground water level. In predicting the slope of the line of saturation in an earth embankment, it is a common mistake to assume a constant quantity of percolation and then vary the slope to overcome the variations in the resistance of each material considered. The slope of the saturation line is determined by the depth of water above some comparatively free outlet, the distance between this outlet and the source of water, and the relative permeability of each part through which the water must pass. The quantity of flow depends upon the slope thus established, and not the slope upon the quantity or permeability of the earth.

Very truly yours,

Chas. E. Gregory.

299 Broadway, New York, Jan. 11, 1909.

REINFORCED CONCRETE IN GREAT BRITAIN is still under government disapproval so far as the loan periods granted by the Local Government Board are concerned. As noted in this journal in the past (see Oct. 8, 1908, p. 402), this government body refuses to grant as long time loan periods on buildings of reinforced concrete, as on those where other building materials are concerned, thus increasing the cost of construction by lowering the value of the bonds when reinforced concrete is used. On the contrary that branch of the government which has charge of government building construction (Office of Works) seems to be in favor of reinforced concrete as is instanced by the large building now being erected in that material for the extension to the General Post Office at St. Martin's-le-Grand, London. This is a six-story structure, containing some nine million cubic feet of contents and built throughout of reinforced concrete faced with granite to harmonize with the present adjoining post office.

A FERRYBOAT WITH AN ELEVATING DECK has been recently launched at Port Glasgow, Scotland. She is named "Finnieston No. 1" and is 104 ft. long with a 45-ft. beam. The elevating deck, which is arranged for transporting vehicles only, is carried on eight steel screws by means of which it can be raised or lowered through a range of 17 ft. A special engine is installed for driving the elevating screws. The moving deck is supported between structural steel columns of which there are four at each side of the deck. The columns are connected at the top by a steel frame work which extends across from side to side of the boat at a height of 25 or 30 ft. above the stationary deck and supports the pilot house. The smokestocks and funnels are placed between the columns outside of the moving deck. A photograph showing this boat in use was published in the "Scientific American," July 17, 1909.

The Destruction by Fire of the Old Timber Bridge at Waterford, N. Y.

By OSCAR HASBROUCK.*

As noted in Engineering News, July 15, 1909, p. 85, the old timber bridge which has spanned the Hudson River from Waterford to Lansingburgh, near Troy, N. Y., for the past century, was destroyed by fire on July 10. As one of the largest and probably the oldest wooden bridge in this country and as one of the few remaining examples of the work of Theodore Burr, this old bridge is worthy of description. Completed in December, 1803, its 106 years of life far surpassed many of the steel and iron structures of the type which has supplanted it.

The Waterford bridge consisted of four spans, 154, 161, 176 and 180 ft., respectively, each of the so-called Burr type of truss. As originally built, it was of hewn timber, resting on masonry piers, and even the connecting pins were of wood. Later repairs, however, added sawn timber and a considerable amount of iron and steel rods and bolts. The original cost of the structure was $60,000. It is illustrated in Johnson, Bryan and Turneaure's "Modern Framed Structures," p. 6, and there commented upon as follows:

THREE OF THE SPANS OF THE WATERFORD BRIDGE ON FIRE.
(The fire has already destroyed the timber sheathing.)

> This is probably the most scientific design for an all-wooden bridge ever invented, and for a half-century it stood unrivalled for cheapness and efficiency for highway purposes in this country.

Each span was carried on three trusses, spaced 14 ft. on centers, and each truss was made up of a horizontal, panelled counter-braced truss, stiffened with two arches, one on each of its sides. The trusses were continuous over the piers. The arches, originally of 7 × 15-in. yellow pine, footed against cast-iron shoes in the masonry and were bolted through the main trusses at each vertical. The floor system consisted of a layer of 2-in. on 3-in. planks, resting on three 7 × 7-in. stringers, which were supported in turn upon 12 × 12-in. floor beams, resting on the lower chord of the truss at each panel point. The floor was divided into two parts by the middle truss and carried a trolley track, a roadway and a 5-ft. cantilevered sidewalk. The whole bridge was enclosed by a roof and side sheathing.

In 1901, partly on account of the deterioration in the structure, but largely to provide for the increased load of large interurban trolley cars, extensive repairs, costing $28,000, were made to the bridge. Additional 4 × 7-in. strips were bolted to the tops of the stiffener arches and intermediate rod hangers were put in to support additional floor beams.

The fire was first noticed by a conductor on a passing street car about 1 p. m., July 10. At that time it was burning in the bottom of the second span from the Waterford side. By the time he had turned in an alarm the bridge was in one mass of flames, fanned by the strong south wind blowing at the time.

The origin of the fire is unknown, although it is thought to have started from a cigar or cigarette thrown out of a passing car. The lead in the joints of the 6-in. gas main carried across the bridge soon melted out and the escaping gas spread the fire quickly to the two adjoining spans. Dense clouds of black smoke rolled up and drove the firemen from the bridge. In about 30 minutes the sheathing of the three west spans had been burned off and the trusses lay a smoldering ruined mass in the river.

After the sheathing had burned off the separate members of each truss stood out boldly. The second span from the Waterford side where the fire started was the first one to go. They all stood up remarkably for some time, testifying to Prof. Johnson's remark. When the second span went, it started as a whole structure at the edge of the pier towards the Waterford side, then the other end started in the same place, evidently due to the arch shoes letting loose, then the whole span as one piece slipped down between the abutments, where it continued to burn until it was destroyed. The reason for its not crashing in the river was probably on account of the track rails which were spiked to the stringers.

The next span toward Troy was the next to go, even though at the time it was only burning badly on the end towards the span that had already gone. The span next to this is still standing and only slightly charred but badly wrecked. Where it joined on with the next span, the truss which was carried through over the top of the pier is broken and splintered and the cast-iron shoes are missing, even though this end was practically untouched by fire.

The third and last span to go was the one on the Waterford side, which went as the others had gone, as a whole structure. The bridge tender's house, which was adjoining the bridge was also burned.

A steel structure will replace the old bridge in time. In rebuilding the old abutments can be used, as they are in good condition. The bridge was a toll bridge and owned by a stock company known as the Union Bridge Co., incorporated in 1803.

*Civil Engineer, 136 Saratoga Ave., North Side, Cohoes, N. Y.

THE SALE OF CEMENT BY STRENGTH and not by volume is virtually proposed by Mr. Richard K. Meade in a paper, "A Suggestion as to Commercial Use to Be Made of Cement Testing," read before the recent annual convention of the American Society for Testing Materials. In the purchasing of materials there has of late grown up a tendency to use as a price standard the work capable of being done by the material rather than the gross amount. Thus in the best present specifications for the purchase of coal, the quality of the coal and the heat units developed are both specified and in addition the price is based upon the heating capacity. A similar idea is proposed by Mr. Meade for the purchase of cement. He would specify the degree of fineness in grinding and the tensile value of a sand-cement mortar as the standards of price, requiring a certain degree of excellence from any cement to be used but increasing the price as the cement increased in excellence of these two items. Along with this he also proposes that the concrete mixture be varied with the tested strength and degree of fineness, so that the amount of cement to be used in a mixture would be gaged by its degree of excellence, judged from the specification, and consequently by its price.

As noted in the title, this is only a suggestion and does not go into the apparently insuperable difficulties connected with the conducting of tests to the satisfaction of three different interests, viz., the cement company, the engineer and the contractor. It should also be stated that the remarkable advantage of fine grinding claimed by Mr. Meade is not accepted by all cement experts.

Disinfection of a Large Dairy Premises and Many Employees After Scarlet Fever.

By CHARLES E. NORTH,* M. D.

A large undertaking in disinfection was recently carried out under the direction of the writer for the Fairfield Dairy Co., of Montclair, N. J. The work included some unusual features that may be of interest to those who find themselves confronted with a similar problem.

The Fairfield Dairy is located near Caldwell, N. J. This dairy produces milk under the patronage of the milk commission of the Essex County Medical Society of New Jersey, the chairman of which, Dr. Henry L. Coit, inaugurated the certified milk movement in the year 1893. The dairy is not only the pioneer but is also the largest single dairy among those producing certified milk. It has a herd of 700 milking animals, owns 1,000 acres of ground, and has in its employ 80 men engaged in milking, farming, and other dairy duties. Every precaution which has been prescribed by sanitary science is enforced and the dairy operations and the milk are of the highest standard. The milk is distributed in the dairy's own wagons to the adjacent communities of Montclair, Bloomfield, the Oranges, Newark and some other towns in New Jersey.†

In the latter part of May, 1909, one of the men employed in milking was observed by the visiting physician to have a sore throat and a high temperature. While his disease could not be accurately diagnosed from these symptoms it was thought best to send him to an isolation hospital in an adjacent town. One week later another man employed in milking showed similar symptoms, but added to them was a decided rash which enabled the physician to diagnose this case as one of scarlet fever. This man was also removed to the isolation hospital at once.

The communities in which the milk was being distributed had a number of cases of scarlet fever, as shown by the records of the boards of health, some of which were consumers of the milk from this dairy. The tabulation of the cases, however, showed them to be distributed among the customers of a number of the milk dealers supplying these towns, but did not furnish any evidence that either they or this particular dairy was the source of the infection. The fact that one positive case and one suspected case of scarlet fever were found among the employees, however, made it necessary to take measures at once to prevent the spread of the disease on the dairy premises.

On June 1, at the request of the Essex County Medical Milk Commission, the writer was summoned to undertake the disinfection of the dairy plant. A survey of the premises showed that there were three dormitories inhabited by the men, a large dairy-house with its outbuildings, and three large cow stables. It was obvious that any partial or intermittent disinfection would be futile, as the large number of people could readily transfer the infection to each other and to the buildings in the course of a few hours. A comprehensive plan which would sterilize so far as possible the buildings, the employees and their garments at one operation seemed the only way to make a disinfection effective. This plan was therefore adopted and carried out in the following way:

MILK.—As soon as the first positive case of scarlet fever was discovered the milk commission directed that all milk should be heated for ten minutes to a temperature of 185° F. before it was taken from the dairy. Mr. Stephen Francisco, the president of the dairy company, is to be particularly commended for his promptness in notifying every customer, by means of a printed slip on each bottle of milk, of the existence of the disease at the dairy and of the heating of all milk.

The temperature used not only destroyed all of the bacteria which were of an infectious type but it also injured the milk in that it prevented the rising of the cream, which the consumer has been educated to expect when milk is delivered in glass bottles. At the writer's recommendation, the temperature was reduced to 150° F. for 30 minutes, this being sufficient to kill all the disease germs and at the same time allow the cream to rise. The considerable loss of trade which the dairy experienced was due more to the destruction of the cream line by the high temperature than to any fear among the milk consumers of infection from scarlet fever. When the cream line reappeared this loss of trade was checked. The heating of the milk was accomplished in the regular 40-quart cans which were stood in a tank of water heated by a steam hose. It was necessary to stir the milk in the cans constantly to maintain an even temperature. When 150° F. was reached the cans were at once removed from the tank to the floor, where they were allowed to remain for 30 minutes, the loss of temperature being only two or three degrees during that time. They were then cooled by passing through the cooler in the usual way, after which the milk was bottled.

The milk from each set of cans was tested for bacteria before and after heating. Before heating, the highest number of bacteria found was 9,600 per cu. cm. The highest number found in milk after heating was 120 per cu. cm. The average of all the bacterial counts of the raw milk during the entire period of 15 days was 2,459 per cu. cm., and of the milk after heating, 42. This gave a numerical reduction of over 98% by the heating process. The bacteria remaining were harmless species, of the spore-forming type, all pathogenic species being destroyed.

EMPLOYEES.—The disinfection of 80 men was a more serious problem. There was no use in disinfecting the men and their clothing until an outfit of sterile clothing could be provided for each man, to prevent re-infection. Accordingly, the dairy company purchased an entire new outfit of clothing, including underclothes, socks, shirts and overalls, for each of the 80 employees. This clothing was all brought to the dairy in the afternoon, where it was placed in a room in one of the outbuildings. All the cracks in this room were blocked with cotton. The clothing was unfolded and loosely suspended. Formaldehyde gas was released from its solution by the lime method, using three times the quantity usually prescribed. The room was closed and the disinfectant allowed to act from 9.30 p. m. until 3.30 a. m. the following day.

In the morning at 3.30 all of the employees on the premises were assembled in one of the dormitories. A number of tubs of water were provided with an abundance of soap and each employee was stripped and given a thorough soap bath, after which he came forward to where an assistant was located with a can of disinfectant, containing chloride of lime in the strength of 0.5% solution. With this he was thoroughly rinsed by means of a clean piece of cheesecloth, after which he was presented with a bundle containing a complete outfit of sterilized clothing. When he was dressed he was dismissed from the building and forbidden to enter any of the other dormitories. In this way each one of the 80 employees was disinfected and dressed in sterile clothing. A sentinel was placed in front of each of the buildings to prevent the entrance of any of the employees until the buildings could be properly disinfected.

BUILDINGS.—There were three buildings used as dormitories by the employees. These contained the beds, bedding, and other furniture, as well as the extra clothing and the lockers of the men. In one of these buildings was a large dining hall and kitchen. All of the crevices in the windows and doors were blocked with cotton, broken glass was replaced with thick paper gummed at the edges, and other openings were closed with heavy pads of gummed paper. Standard formaldehyde solution was used at the rate of 3 pts. per 1,000 cu. ft. of space, distributed in small cans on different floors of the buildings and released by the lime method. The time of exposure was six hours. At the end of this period the buildings were opened and all of the woodwork, floors, walls, and furniture were saturated with a 1% solution of chloride of lime, applied with brushes and cloths.

The dairy house was disinfected by the use of a steam hose. All glassware was sterilized in the usual way in a steam-pressure chest and the large apparatus by streaming steam. Disinfection of the cow stables was not attempted, for the reason that they are so extensive and but little exposed to the infection. All employees entering the cow stables regularly change clothing for damp and sterile milking clothes. The floors and walls, as well as the air, are kept moistened with a spray of water to prevent dust.

The dormitory disinfections were tested by means of control cultures of bacteria. The species chosen was the colon bacillus, a fresh agar slant of which was dissolved in a little water and applied to a dozen pieces of small cord. Six of the cords moistened with this culture were distributed about the buildings and remained within them during the discharge of the gas. The other six cords were kept as controls for comparison. These were later on taken to the laboratory, where all were implanted in fermentation tubes containing lactose-bile medium and incubated for 24 hours. At the end of that time all six of the tubes containing the cords which had not been exposed to the disinfection showed an abundant formation of gas in the closed arm, which is a typical reaction for the colon bacillus. The tubes containing the six cords which had been exposed to the disinfection gave no gas, indicating that the colon bacillus had been destroyed.

CLOTHING.—The over-clothing of the employees, such as trousers, hats, coats, and shoes was distributed about the dormitories on wires so that they would be loosely exposed to the disinfectant. All other clothing, such as underwear, shirts, and socks left in the buildings by the men, as well as the contents of their lockers, trunks, and boxes, and all loose bedding, was carried to the steam laundry on the premises, where they were sterilized by boiling and thoroughly laundered. After this they were hung out on fences exposed to the air and sunlight to dry.

The heating of the milk was continued for 15 days from the date of the removal of the last sick employee (the only positive case). At the end of that time, there having been no other signs of the disease, the heating was discontinued and the dairy resumed business as usual.

It is not claimed that the above plan included the disinfection of every lurking place of the scarlet fever contagion. The uninterrupted operation of the plant made absolute disinfection impracticable. The writer can name a number of possible resting places for the infection. Among them were the throats and noses of the employees. These were, however, examined daily by the visiting physician and showed in no case any sign of inflammation during the period of quarantine. If the bacteria or other organisms which cause scarlet fever were present on the premises the writer believes that such a disinfection as has been described would go far towards destroying them. But in any event, the heating of the milk during the quarantine period gave the milk consumers absolute safety from infection.

*Of North & Phelps, Consulting Sanitary Experts, 30 Church St., New York City.

[†It should not be understood that the whole product of this dairy is certified milk; but all the milk produced shares largely in the benefits of the certification plan.—Ed.]

Notes from Engineering Schools.

ROSE POLYTECHNIC INSTITUTE.—A bequest of about $450,000 has been received by the institute from the late Susan F. Heminway, who was the only surviving relative of Chauncey Rose, founder of the school. The entire amount will not become available at once, but will be added to the productive endowment of the institute, and the proceeds will be used for the purpose of adding to its equipment. Reports state that the bequest includes a tract of land in the heart of Terre Haute, Ind., which was formerly a part of the Rose estate.

Leffert Lefferts Buck.

L. L. Buck, M. Am. Soc. C. E., formerly Chief Engineer of the Bridge Department of New York City, died very suddenly from apoplexy at his home in Hastings-on-Hudson, N. Y., on the morning of July 17. Mr. Buck was born in Canton, N. Y., in 1837. His early schooling was in the Canton Academy, but before completing his course there he left school and served an apprenticeship to the machinist's trade. In 1859 he entered St. Lawrence University, but left two years later at the outbreak of the war, to enlist as a private in the 60th New York Volunteers. He served all through the war, and was mustered out in 1865 with the rank of captain. Immediately following his discharge from the army he entered the sophomore class of Rensselaer Polytechnic Institute and graduated in the class of 1868.

His most notable work in the early years of his engineering practice was done in Peru, where Henry Meiggs was then engaged in constructing the famous Lima & Oroya road. Mr. Buck was connected with the construction of the great Verrugas Viaduct on this road. In 1877 he returned to the United States and engaged in general practice as an engineer. Among his early achievements was the reinforcement of the anchorage of one of the Niagara Falls suspension bridges while the bridge was in service. Two years later he renewed the suspended superstructure of the railroad suspension bridge at Niagara. A decade later he rebuilt both the highway and railway suspension bridges as steel arches. During 1880 and 1881 he was engaged in special work for the Central Railroad of New Jersey. During the latter part of the '80's he was in partnership with George W. McNulty, M. Am. Soc. C. E. When the City of New York undertook the construction of the Williamsburg Bridge over the East River, Mr. Buck was placed in charge, and he was connected with the Bridge Department, in one capacity or another, from that time forward. About the time the bridge was completed, Mr. Buck's health failed and he spent some time in a sanitarium, threatened with loss of his mental powers. He recovered, however, so that he was able to continue practice.

Mr. Buck remained a bachelor until 1902, when he married Miss Mira R. Gould, of Paducah, Ky., who survives him.

Mr. Buck became a member of the American Society of Civil Engineers in 1875. He was a director of the society from 1892 to 1894, and was awarded the Norman medal for a paper contributed to the Transactions. He was also a member of the Engineers' and Century Clubs, the Military Service Institution and the Loyal Legion. The funeral took place at Hastings-on-Hudson on Sunday, July 18, and the interment was at Mr. Buck's native town of Canton, N. Y.

A HEAD-ON COLLISION near Shultz, Mich., July 15, between a passenger and a freight train on the Chicago, Kalamazoo & Saginaw Ry., resulted in the death of the engineer and fireman of the passenger and seriously injured the engine crew of the freight. The accident occurred about one-half mile north of the Shultz station, which the northbound passenger train had just left. The collision is ascribed to a misunderstanding of train orders. On this railway, train orders are transmitted by telephone from the superintendent's office at Kalamazoo to the various station agents.

A PASSENGER TRAIN COLLIDED HEAD-ON with a sheep train on the Denver & Rio Grande R. R., July 10, near Cisco, Utah. Three of the train crew of the passenger were killed. The collision is ascribed to a confusion of train orders.

THE EXPLOSION OF A BLASTING CHARGE while it was being tamped caused the death of seven workmen July 20 near Blairstown, N. J. The men were at work on the cut-off being constructed by the Delaware, Lackawanna & Western R. R.

AN EARTHQUAKE IN SOUTHERN GREECE July 15 destroyed hundreds of houses in the Province of Elis. All the buildings in several villages were rendered uninhabitable. Reports state that 300 persons were killed.

TWO SEWER CLEANERS WERE SCALDED by live steam blown into a sewer from a hotel in New York City a few days ago. One man, new at the work, was probably injured fatally, but the other, an old sewer cleaner, saved himself from serious injuries by "ducking" into the sewage. The local police magistrate discharged the steam engineer of the hotel on the ground that the sewer cleaners should have notified the hotel management that they were about to enter the sewer.

A CARGO STEAMER SUNK THE SUBMARINE "C. 11" of the British navy July 14 at a point 4½ miles northwest of the Raisborough Lightship near Cromer, England. Of the 16 men composing the submarine's crew, 13 were drowned. The "C. 11" was one of a flotilla of eight submarines convoyed by the cruiser "Bonaventure." The cargo steamer "Eddystone" ran through the submarine flotilla, ramming the "C. 11" and narrowly missing collisions with two of the other boats.

THE GOOSE NECK BAR LIGHTHOUSE WAS SUNK in the Delaware River on the night of July 18 by the British steamship "Raithmoor." The lighthouse had just been practically completed but was still in the hands of the contractor. The "Raithmoor" was bound for Philadelphia from Lulea, Sweden, and was loaded with 4,500 tons of iron ore. Before striking the lighthouse, she cut through a scow and overturned a floating pile-driver which were moored near the lighthouse. Although the lighthouse was knocked completely over and sank, the steamer was only slightly damaged. The accident is ascribed by the ship's officer to a misleading arrangement of lights by the contractors.

THE COLLAPSE OF A BUILDING under reconstruction in Philadelphia on July 15 caused the death of 7 workmen and the very serious injury of 2 others, in addition to some 25 workmen and passers-by who were more or less seriously injured. The building which collapsed was an old five-story structure about 20 × 100 ft. in plan, located on the northeast corner of Eleventh and Market Sts. It was built some 50 years ago as a three-story brick-wall and timber-framework structure, and at some later period was increased to a five-story building. The reconstruction work which has recently been going on consisted in the removal of the previous second floor so as to make one large exhibition room the height of the first two stories. In order to do this, needle beams had been inserted under the walls, supported outside and inside by 36-ft. 8 × 8-in. yellow pine shoring approximately 2 ft. 6 ins. to 4 ft. c. to c. and resting on 12-in. wooden sills on the pavement. The needles were composed of some 8-in. I-beams, some 10-in. I-beams, and in a few instances of three small-sized rails. The accident occurred shortly after the lunch hour, when all the men were working in the building and when a large number of people were passing the very busy corner. The men who were in a position best to note the cause of the collapse were killed or are so seriously injured that they cannot give any definite information; but from the best available testimony the collapse was very sudden and was not preceded by any preliminary cracking. From a line half-way down the long side of the rectangle the building completely collapsed, carrying down with it the walls and framework and burying workmen and passers-by.

A report on the accident has been transmitted to the Mayor by the Chief of the Bureau of Building Inspection, in which the latter says that the accident may have been due to one of four causes: (1) The displacing of one of the shores by a steel girder which was being swung into the building about the time of the collapse; (2) the attaching of a block-and-fall to some of the sills or the shoring, to raise this girder; (3) the removal of some of the shoring to allow the passage of this girder; and (4) the collapse of the fourth floor under the excessive loading of a block-and-tackle which was placed there to move the aforesaid girder. This latter the Chief assumes to be the most probable of the four. On account of the very weak floor system on this fourth floor due to the addition placed some years before, it is probable that any heavy load brought upon it would have caused collapse, and such evidence as is available would seem to show that a block-and-tackle had been placed at about the weakest point on the floor.

Further investigation is in progress and it is expected that some judicial action will be taken upon the matter.

THE McCALL FERRY POWER COMPANY, which is constructing an immense power plant on the Susquehanna River, at McCall Ferry, Pa., has gone into the hands of a receiver. This company became involved in financial difficulties at the time of the panic in the fall of 1907 and has been unable to recover. The present receivership, however, is in the nature of a friendly move on the part of the holders of the mortgage. It is expected that the difficulties will soon be over and work, which stopped some months ago, will be resumed at the plant. The construction was fully described in our issue of September 12, 1907, page 267.

THE GUNNISON TUNNEL HEADINGS, which were joined on July 6, met with great accuracy. The tunnel is about six miles long, yet the survey lines of the two ends differed only 0.04-ft. in alinement, 0.32-ft. in level, and 0.86-ft. in distance.

THE NEW YORK CITY BUILDING CODE, which was passed by a vote of the Board of Aldermen, as noted in our issue of last week, will possibly not be passed upon by the Mayor for some weeks. According to the charter the Mayor must pass upon such cases within ten days, but certain technicalities in regard to the transmission of the vote from the Board of Aldermen to the Mayor's office has made it possible for this latter official to withhold his decision until the next meeting of the Board in September. Considerable objection to the code has developed and a large mass-meeting was held on the night of July 20th by the interests opposed to its adoption. A public hearing by the Mayor was also held later in the week.

THE LOWER HUDSON TUNNELS WERE OPENED to traffic on Monday, July 19. These are two cast-iron tube shield-driven tunnels under the Hudson River between New York City and Jersey City. Their easterly ends are in Fulton St. and Cortlandt St., New York, about 500 ft. apart, while the New Jersey ends join in a station excavated in rock directly below the Pennsylvania R. R. Terminal trainshed. The tunnels connect at the New York end by loop tracks passing under the Hudson Terminal Buildings, on Church St. The westerly end will connect by a north-south line with the Morton St. or Upper Tunnels of the same system, which have been in operation for a year past. The connection will not be ready for traffic for two weeks more. The Lower Tunnels, giving direct access from Jersey City and Hoboken to the heart of the financial district, are expected to take a large part of the traffic which in the past has been served by the ferries. The completed system passes the Erie, Lackawanna and Pennsylvania stations and gives their passengers much quicker transportation to New York, reaching the financial district via the Lower Tunnels and the shopping, theater and hotel district by the Upper Tunnels, the latter also making close connections with the New York City Terminal of the Pennsylvania R. R. Extension and by a newly authorized line with the Grand Central Terminal of the New York Central and New Haven railways. The Pennsylvania will furnish its inbound passengers free transportation through the tunnels, but for passengers of the other railways the ferry service, being free to passengers, will continue to compete with the extra-fare tunnel service.

The leading figures in the development of this tunnel system have been W. G. McAdoo, President, and Charles M. Jacobs, Chief Engineer of the Hudson Companies. The operating company is the Hudson & Manhattan R. R. Co.

ORVILLE WRIGHT established a new American record for aeroplane flight of 1 hr., 20 min., 45 sec., at Fort Meyer, Va., on July 20, with the flyer which the Wright brothers are under contract to furnish the Signal Corps of the U. S. Army. This is not quite equal to the record of 1 hr., 53 min., 59 sec., made by Wilbur Wright, at Le Mans, France, in December, 1908. The maximum height reached in this latest flight was some 300 ft., which is about the same as during the record flight in France. The average height is reported to be 150 ft., which contrasts with the average of 25 ft., generally held to in the trials of a year ago. The distance covered this time was about 60 miles.

Other notable aeroplane flights have been made recently by experimenters here and abroad. Glen H. Curtiss, at Hempstead Plains, Long Island, near New York City, on July 14, made a flight of five miles. On July 16, a flight of 15 miles was made, and on July 17, this was raised to 24.7 miles. The time of this last flight was 52 min., 30 sec. The Curtiss machine has two horizontal supporting planes and in general appearance much resembles the type developed by the Wright brothers. The propeller is mounted directly on the engine shaft, however, and rubber-tired wheels are used instead of skids. This machine was wrecked by an amateur on July 18, after reaching a height of 40 ft.

Herbert Latham made a long-promised attempt to cross the English Channel with an Antoinette monoplane flyer, on July 19. The start was made in spectacular form from the chalk cliffs near Calais. When about 12 miles out the gasolene motor began to give trouble, due to a poor carburettor, it is reported, and the aviator was obliged to descend. The descent was made easily and without great damage to the machine. The flyer and operator were picked up by the French torpedo-boat destroyer "Harpon," which accompanied the machine in its trial. Another attempt will be made in a few days.

HEAVY RAINFALL IN MEXICO during the latter half of June and the first week of July caused disastrous floods in the states of Nuevo Leon and Coahuila.

The town of Villaldama, Nuevo Leon, according to reports, was entirely flooded and many of its houses were washed away. A large part of the population was compelled to flee to higher ground. At Las Ramonas, a small town on the Matamoros branch of the National R. R. of Mexico, 15 persons are reported to have been drowned. About 35 railway bridges and 200 kilometers of track have been washed out on lines entering Monterey, Nuevo Leon. During the first four days of July no trains were run on the railways north from Monterey nor over the Matamoros division.

THE PENNSYLVANIA CAPITOL grafters who were convicted of conspiracy to defraud the state in March, 1908, have been defeated in their appeal to a higher court to set aside their conviction. The Superior Court of Pennsylvania on July 14 made public its denial of the appeal and its approval of the conviction of the four men. Two of those convicted, the contractor, Sanderson, and the ex-state treasurer, Mathues, have died since the prosecution began. The former auditor-general, Snyder, and the former superintendent of grounds and buildings, Shumaker, have been out on bail since conviction and sentence pending the decision of the higher court. The architect, Huston, who had his case separated from the others, has not yet been brought to trial.

THE ERIE CANAL BREAK at Spencersport, N. Y., noted in our issue of July 8, continued to give trouble during the ensuing week. On July 3 the repairs were supposedly completed and the water let into the level, but when about 3 ft. head had been admitted another leak showed up over Culvert 49, some feet away from the leak which had been repaired, and the water was again drawn off. Final repairs were not made until July 5 and the water then was slowly let into the level without any perceptible leakage. The controversy as to whether these leaks over culverts are due to poor design or poor construction is still on and no official reports have been made, though representatives from the offices of Superintendent of Public Works, the State Engineer and from the contractor are all talking rather freely and extensively for the daily press.

THE RECORD FOR HEAVIEST FREIGHT TRAINS has again been beaten by the Pennsylvania Railroad. In our issue of July 1, p. 27, we noted the hauling on June 14 of a train weighing 6,151 tons. On June 22 a train of 7,644 tons was hauled by the same locomotive, No. 1113. The train consisted of 105 steel cars loaded with 5,544 tons of coal and the run from Altoona to Harrisburg, 127 miles, was made in 7 hours, 12 minutes, or an average speed of 17.6 miles per hour.

This record movement marks the culmination of a series of tests made for the purpose of determining the hauling power of the most improved types of locomotives used in the regular freight service of the Pennsylvania Railroad over the best grades of the system. That part of the line over which the test was made, from Altoona to Enola, presents at no point a greater grade than 12 ft. per mile.

Locomotive No. 1113, which drew this train, is of the H-8-b type. It was built at the Altoona shops of the Pennsylvania Railroad and has a tractive power of 42,661 lbs.

The runs made during the month of June, which exceeded in train-weight any previous records, were as follows:

Date, June.	Engine No.	No. Cars.	Total wt. of Train, Tons.	Time. Hrs.	Time. Mins.
3	3,212	85 Mixed	4,852	12	30
5	1,641	86 Mixed	4,922	9	42
8	2,905	87 Mixed	4,623	10	21
8	451	75 Steel	5,348	10	12
8	2,903	75 Steel	5,348	8	2
8	3,212	75 Steel	5,307	10	21
14	1,113	85 Steel	6,151	7	15
18	....	94 Steel	6,922	7	31
22	1,113	105 Steel	7,644	7	12

AN INJUNCTION AGAINST THE CROTON AQUEduct Commission, New York City, to prevent the construction of the proposed Patterson Reservoir, in the northeast portion of the Croton drainage area, has been asked for in a taxpayer's suit brought in behalf of the Merchants' Association of New York. It is alleged by the plaintiff that the reservoir is unnecessary, in view of the proposed Catskill supply, and that its construction would be unwarranted in any case in view of the fact that the Croton drainage area is already developed at least to its economic limit. It is also alleged that the proposed construction is invalid, because of failure to secure approval of the plans for the reservoir by the Commissioner of Water Supply, Gas & Electricity of New York City. It is further alleged that the real motive for building the reservoir is a desire to keep the Aqueduct Commission in existence. Articles discussing further water storage in the Croton drainage area appeared in our issue of Feb. 6, 1908.

THE INDEPENDENT TELEPHONE COMPANIES of the country met at Parkersburg, W. Va., July 10, in conference on merging into a "National Telephone Corporation of New York" with a capitalization of $100,000,000. The conference was adjourned until August without final action and on account of fixing details of the consolidation, it is reported. The conference was under the auspices of the West Virginia Western Telephone Co., one of the leaders of the movement.

Personals.

Mr. C. E. Chambers, Division Master Mechanic of the Central R. R. of New Jersey at Jersey City, N. J., has been made General Master Mechanic.

Mr. Thomas J. Burns, Chief Clerk of the motive department of the Michigan Central R. R., has been made Assistant Superintendent of Motive Power.

Mr. Paul A. Kirchner, Structural Engineer of the New York, Westchester & Boston Ry. Co., has resigned that position and will take a two-months' trip in Europe.

Mr. A. C. Lane, M. Am. Inst. M. E., has resigned his position as State Geologist of Michigan to become a member of the faculty of Tufts College, Boston, Mass.

Mr. R. L. Hatfield, Roadmaster of the Houston Division of the Missouri, Kansas & Texas Ry., has resigned to become Assistant Superintendent of the Wichita Falls & Southern Ry.

Mr. A. J. Reef, Construction Engineer for the Oak Hills Coal Co., at Oak Creek, Colo., will, on Aug. 1, become Designing and Constructing Engineer for the Victor Fuel Co., of Denver, Colo.

Mr. Winfred D. Gerber has resigned his position as Chief Engineer of the Licking River R. R., and is now associated with Mr. W. S. Shields, civil and sanitary engineer, 1201 Hartford Bldg., Chicago.

Mr. Chas. T. Banks has resigned as Superintendent of the W. M. & P. division of the Chicago Great Western Ry. The jurisdiction of Mr. C. E. Dafoe, Superintendent of the Northwest division, has been extended to include the division formerly superintended by Mr. Banks.

Mr. John J. L. Houston has been appointed Assistant Engineer, Department of Parks, Boroughs of Brooklyn and Queens, New York City, with headquarters at Prospect Park in Brooklyn. Previously to this appointment, Mr. Houston was a topographical draftsman in the park department.

Mr. W. S. Gearhart, Assoc. M. Am. Soc. C. E., at present with the Illinois Highway Commission, has been appointed Highway Engineer in charge of road and bridge improvement in Kansas. The work will be begun in September under the direction of the Kansas State Agricultural College, Manhattan, Kan.

Mr. M. L. Newman and Mr. Alfonse Kaufman have opened an office as consulting industrial engineers under the name of M. L. Newman & Co., at 25 Broad St., New York City. Mr. Newman was formerly employed by the Government at the Brooklyn Navy Yard, and Mr. Kaufman was recently Manager of the Alaska Chemical Co.

Mr. William B. Phillips, M. Am. Inst. M. E., of Birmingham, Ala., has been appointed to the directorship of the bureau of economic geology recently established by the Board of Regents of the University of Texas. The purpose of the bureau is the investigation of and distribution of information concerning the state's mineral resources. Mr. Phillips was formerly in charge of the Geological Survey in Texas, which was discontinued in 1905. He will assume the duties of his new position in September.

Mr. Elwood Mead, M. Am. Soc. C. E., M. Inst. C. E., now of Melbourne, Australia, has signed a contract with the State of Victoria to remain in Victoria five years after July 1, 1909, at $10,000 a year, and to serve as Chairman and Chief Engineer of the State Rivers and Water Supply Commission. Mr. Mead was for a number of years Chief of Irrigation and Drainage Investigations, Office of Experiment Stations, U. S. Department of Agriculture, with headquarters at Washington. He was also Professor of Irrigation Institutions at the University of California, Berkeley, Cal. Before taking up work with the U. S. Government he was State Engineer of Wyoming, in which capacity he did much to build up the Wyoming policy and practice as to the appropriation and use of water for irrigation.

Obituary.

Thomas W. Bakewell, a prominent patent lawyer, died July 7 in the U. S. Circuit Court at Pittsburg, Pa. Mr. Bakewell had made a specialty of cases involving iron and steel, and especially the electrometallurgy of steel. He was attorney for the U. S. Steel Corporation, Bethlehem Steel Co., and numerous other metal firms, and was a charter member of the American Electrochemical Society. His home was in Plainfield, N. J., and he maintained offices in Pittsburg and in New York City.

Egbert P. Watson, founder of the "Mechanical Engineer" and for five years an editor of the "Scientific American," died June 22 from paralysis. Mr. Watson was born in New York City in 1835. After five years as an apprentice in marine engine and locomotive shops in the East, he went to Detroit, Mich., where he was at first in the employ of the Michigan Central R. R., but soon became a marine engineer on the Great Lakes. A few years later he returned to New York City and worked for some time as a lathe hand before becoming one of the editors of the "Scientific American." He founded the "Mechanical Engineer" in 1881 and remained at its head for 16 years. He was the author of a number of books on machine shop and engine-room practice.

George Frederick Deacon, M. Inst. C. E., M. Inst. M. E., a prominent English water-works engineer, died June 17 at his office in London. Mr. Deacon was born at Bridgwater, Somersetshire, in 1843, and during his 17th year he entered the marine engineering works of Robert Napier & Sons on the Clyde River as a special apprentice. At the age of 20 years he entered Glasgow University and studied under Professor Macquorn Rankine and under Lord Kelvin. He did not complete his course at the university but, at the beginning of his second year of study, left school to become Assistant Engineer of the Atlantic Telegraph Co. In this capacity he participated in the unsuccessful effort to lay the Atlantic cable which was made in 1865 with the "Great Eastern."

It was in this same year that Mr. Deacon first began practice as a consulting engineer in Liverpool. In 1870 he was appointed to lecture on engineering at Queen's College, Liverpool, now the Victoria University, and in the following year he became Borough and Water Engineer of Liverpool. Immediately after his appointment to this position, which he held for eight years, he made a close study of the sewerage of the city, and during his term of office he constructed 35 miles of new sewers and repaired 41 miles of those already existing. In 1872 he introduced destructors for the disposal of sewage, but seven years later, on account of the large quantity to be dealt with, hopper barges were adopted and the refuse dumped at sea.

Mr. Deacon held several medals awarded to him for papers presented before the Institution of Civil Engineers. In 1879 he received the Watt Medal and Telford Premium for a paper on the design and construction of street pavements; in 1874 he was awarded the Telford Medal and Premium for a paper describing the waste-water meter system introduced by him at Liverpool, and a third paper, on the Vyrnwy Dam, contributed in 1895 obtained for him the George Stephenson Medal and Telford Premium. Since 1900 he has served continuously on the council of the institution.

Engineering Societies.

COMING MEETINGS.

NATIONAL IRRIGATION CONGRESS.
Aug. 9-14. Annual meeting at Spokane, Wash. Secy., B. A. Fowler, Phoenix, Ariz.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 25-27. Annual convention at Montreal, Can. Secy., John MacVicar, Des Moines, Iowa.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Aug. 31-Sept. 2. Annual meeting at Briarcliff Manor, N. Y. Secy., D. L. Huntington, Spokane, Wash.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual convention at Denver, Colo. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 8-10. Annual convention at New York City. Secy., Willard Kent, 715 Tremont Temple, Boston, Mass.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 14-16. Annual convention at Atlantic City, N. J. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 14-17. Annual meeting on board steamer sailing from Detroit, Mich. Secy., A. P. Ewing, Gas Office Bldg., Detroit, Mich.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-Oct. 12. Annual convention and excursion on special train starting at Chicago, Ill. Secy., R. W. Raymond, 20 W. 39th St., New York City.

AMERICAN STREET & INTERURBAN RAILWAY ASSOCIATION.
Oct. 4-8. Annual convention at Denver, Colo. Secy., Bernard V. Swenson, 29 W. 39th St., New York City.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.—The annual meeting will be held at Denver, Colo., Oct. 7-9, in conjunction with the convention of the American Street and Interurban Railway Association. Papers will be read on "The Commercial Field," "Meters and Testing" and on "Lamps and Illumination." The secretary is Mr. J. C. Lawler, P. O. Box 938, Colorado Springs, Colo.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.—At the annual convention in Grand Rapids, Mich., Aug. 17-20, papers will be presented as follows: "Advisability of Discarding Steam Fire Engines in Cities Where an Efficient and Complete High Pressure Water Service Has Been Installed," by Geo. A. Wallace, Cleveland, Ohio; "The Automobile as a Fire-Fighting Appliance," by Jno. O. Glanville, St. Louis, Mo.; "Rubber Tires for Fire Apparatus," Fred Morrison, Watertown, N. Y.; "Spontaneous Combustion," R. H. Nesbit, Waukegan, Ill.; "Comparison of Fire Risks in the United States and Foreign Countries, and Discussion of Needed Reforms in Building Construction," Geo. C. Hale, Kansas City, Mo.; "Fire Prevention," G. E. Bruen, New York City.